US Army Corps
of Engineers
St. Paul District

MINNESOTA RIVER AT CHASKA, MINNESOTA FLOOD CONTROL PROJECT

DESIGN MEMORANDUM NO. 1
CHASKA CREEK

DECEMBER 1984

REPORT DOCUMENTATION PAGE	*Form Approved* *OMB No. 0704-0188*

1. REPORT DATE *(DD-MM-YYYY)*
12/84

2. REPORT TYPE
Final

3. DATES COVERED *(From - To)*

4. TITLE AND SUBTITLE
Minnesota River at Chaska, Minnesota flood control project: design memorandum no. 1, Chaska Creek.

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Corps of Engineers, St. Paul
190 5th St. E.
St. Paul, MN 55101

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution

13. SUPPLEMENTARY NOTES

14. ABSTRACT
This design memorandum presents the design and discussion of planning for Stage 1, which consists of construction of a diversion channel and channel modifications to Chaska Creek and a portion of the Minnesota River levee on the west edge of the city of Chaska.

15. SUBJECT TERMS
Flood control
Minnesota River

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
Unclassified	Unclassified	Unclassified			19b. TELEPHONE NUMBER *(Include area code)*

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
1135 U. S. POST OFFICE & CUSTOM HOUSE
ST. PAUL, MINNESOTA 55101

REPLY TO
ATTENTION OF:

NCSED-M

SUBJECT: Flood Control, Minnesota River at Chaska, Minnesota, Design Memorandum No. 1, Chaska Creek

Commander, North Central Division

1. The subject design memorandum is submitted in accordance with Engineer Regulation 1110-2-1150.

2. This design memorandum presents the design of improvements for construction of a diversion channel and related structures along Chaska Creek on the west edge of Chaska, Minnesota.

3. I have met with officials from the city of Chaska to discuss project cost-sharing. The city understands and fully supports this project. They have indicated their interest in participating in cost-sharing at a percentage of total project costs which conforms to the cost-sharing policy developed by the Administration and the Congress for flood control projects.

1 Incl (16 cys)

EDWARD G. RAPP
Colonel, Corps of Engineers
Commanding

FLOOD CONTROL
MINNESOTA RIVER AT
CHASKA, MINNESOTA

DESIGN MEMORANDUM NO. 1

CHASKA CREEK

DESIGN MEMORANDUM SCHEDULE

Number	Scheduled Completion	Submitted NCD	Submitted OCE	Approved
- General	Mar 84	6 Mar 84	May 84	July 84
1 Chaska Creek	July 84	Dec 84		
2 East Creek	85			
3 Minnesota River Levees	86			

PERTINENT DATA

Project Document - House Document 94-644, 94th Congress, 2nd Session.

Project Authorization - 1976 Water Resources Development Act (Public Law 94-587).

Project Purpose - Flood Control.

Location - The project is located on the Minnesota River in Carver County and Chaska, Minnesota, and includes both Chaska and East Creeks, which are tributaries of the Minnesota River.

Hydrology and Hydraulics

Watershed Drainage Area	26.8 Square Miles
Design Flood Frequency	Standard Project Flood
Design Flows	
Chaska Creek Diversion	6,040 cfs
East Creek Diversion	6,200 cfs
Minnesota River	168,000 cfs

Principal Items of Work

Diversion Channel	7,100 LF
Channel Improvement	1,500 LF
Levee Improvement	5,800 LF
New Levee	7,800 LF
Cut and Cover Conduit, 16' X 16' Box	1,500 LF
Inlet Structures	2
Outlet Structures	2
Drop Structures	1
Pumping Station	1
Bridge Removals	2
Bridge Replacements	7

Economics

Federal first cost	$20,920,000
Non-Federal first cost	3,843,000
Total first cost	24,763,000
Average annual operation & maintenance cost	43,900
Total average annual cost	2,176,400
Average annual benefits	2,486,600
Benefit-cost ratio	1.14

FLOOD CONTROL
MINNESOTA RIVER AT
CHASKA, MINNESOTA

DESIGN MEMORANDUM NO. 1
CHASKA CREEK

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT)

TABLES

PLATES

TABLE OF CONTENTS (CONT)

PLATES (CONT)

APPENDIXES

SCOPE AND LOCATION

1. The local flood protection project at Chaska, Minnesota, is divided into three stages of construction (see plate 2). This design memorandum presents the design and discussion of planning for Stage 1, which consists of construction of a diversion channel and channel modifications to Chaska Creek and a portion of the Minnesota River levee on the west edge of the city. Work to be done includes approximately 5,800 feet of channel modifications, two control structures, two side drainage structures, four bridge alterations, and about 2,200 feet of Minnesota River levee.

PROJECT PLAN-GENERAL

2. As discussed in the general design memorandum, the flood control project consists of three stages of construction: Chaska Creek, East Creek, and Minnesota River levee improvements. Also included are recreational improvements, an environmental mitigation plan, and aesthetic considerations.

DEPARTURES FROM APPROVED GENERAL DESIGN MEMORANDUM

3. The design presented here essentially conforms to that shown in the general design memorandum.

HYDROLOGY AND HYDRAULICS

4. Hydrologic data for the Chaska area are given in the limited reevaluation report of August 1982 and were modified for East Creek in the general design memorandum. Appendix A of this design memorandum presents the final design for Chaska Creek and a review of hydraulic design for the Minnesota River levee included in this stage.

GEOLOGY

5. Discussions of the geology for the project area are given in the general design memorandum and appendix B of this report.

DESCRIPTION OF PROPOSED STRUCTURES AND IMPROVEMENTS

CHANNELS

6. Channel modifications on Chaska Creek will extend from the outlet structure and channel south of Spruce Street upstream 5,800 feet to the inlet structure and channel north of Highway 212. The new channel will divert flow from the existing channel at about station 51+00 to the downstream end. The existing channel will remain as a ponding area and to carry local runoff and will reenter the diversion at station 29+00 through Outlet A. Between the inlet and outlet structures (stations 64+33 to 21+82)the channel is rectangular reinforced concrete and designed for supercritical flow. The channel bottom width changes from 35 feet above

to 37.5 feet below the side drainage inlet at station 42+00. The upstream approach channel is a 667-foot-long riprap trapezoidal section with 1V on 3H side slopes and a 35-foot bottom width. The downstream exit channel is approximately 881 feet long, has riprapped 1V on 3H side slopes for 459 feet and has grass lined IV on 3H side slopes for 422 feet. It varies in width from 75 feet at the outlet structure to 20 feet at the terminus.

LEVEES

7. Construction of a portion of the Minnesota River levee has been included in Stage 1 to facilitate design and construction adjacent to Chaska Creek. The levee will have a top width of 10 feet at elevation 728.5 and 1V on 3H side slopes.

STRUCTURES

GENERAL

8. Reinforced concrete structures include: stilling basin; supercritical flow channel; bridges at First street, the Chicago and Northwestern Railroad, Hickory Street and Hillside Drive; ogee crested spillway; subcritical flow channel; inlet structure; drainage channel including side inlet, box structure, transition structure, and drop structure; and outlet A including flared end section, sluice gate well, flap gate well, manholes with grated inlets, outlet, and reinforced concrete pipe.

9. The channel, channel structures, bridges, and drainage structure all have some common features. These structures will be backfilled alongside and underneath with a minimum of 1 foot 6 inches of free-draining granular material. Two inches of polystyrene insulation will be placed around the structures together with 4 inches of sand directly beneath the structures. Weep holes will be provided at 40 feet on center, 1 foot off the bottom along each side. Sheet-pile cutoffs will be constructed every 440 feet. This system will prevent frost heave because any ice formation will displace water and force it out the weep holes. Frost will not penetrate below the frost-free material. The structures were designed so that if the drains are only 50 percent effective and the channel is dry, no uplift problems will develop. Drains were spaced at 40 feet on center to provide enough water flow through each to prevent freezing. Chain link fencing will be provided along the entire open channel to prevent access to the channel.

STILLING BASIN

10. The downstream stilling basin is located from station 21+82 to station 22+54 and is 37.5 feet wide. The stilling basin provides a parabolic drop from elevation 707.54 to elevation 696.5 into a Saint Anthony Falls type stilling basin with a preformed scour hole downstream. In addition, an end sill, six baffle blocks, and seven chute blocks are provided to help dissipate energy.

SUPERCRITICAL FLOW CHANNEL

11. The supercritical flow channel extends from the upstream end of the stilling basin at station 22+54 to the downstream end of the ogee crested spillway at station 62+45. The channel is 37.5 feet wide downstream and 35.0 feet wide upstream of station 41+00. The bottom of the straight portions of the channel slopes toward the middle from both sides at a 2-percent slope. Horizontal spiral curves are used to transition from straight reaches to curved reaches and back again to straight reaches. On curves the channel bottom is superelevated to maintain supercritical depth. The channel walls are generally 9 feet 3 inches high and 1 foot 4 inches thick. Base slabs are generally 2 feet thick.

BRIDGES

12. Bridges will be constructed across the channel at First Street, the Chicago and Northwestern Railroad, Hickory Street, and Hillside Drive. The roadway bridges will be designed as rectangular box culverts and will use the channel walls and base slab as part of the bridge structures. Bearing piles will be required to support the First Street bridge. The railroad bridge has a thru girder ballasted deck supported by concrete piers on piling. The piers form a portion of the channel walls. All bridges will clear the SPF design water surface profile by at least 2 feet, will have no piers in the channel, and will not alter the channel width. Traffic will be detoured during construction. Design of the railroad bridge was coordinated with the railroad company. The bridge was designed according to AREA 1983-84 Manual for Railway Engineering. A shoo-fly will be constructed to detour rail traffic during construction.

13. An existing bridge on Highway 212 crosses the channel. However, the channel will pass beneath the bridge with only minor modifications to channel design.

OGEE CRESTED SPILLWAY

14. An ogee crested spillway will be constructed near the upstream end of the channel diversion from station 62+45 to station 62+74. It will provide transition from subcritical to supercritical flow. The structure will be 35 feet wide, have a maximum wall height of about 27 feet, and will provide a 10-foot drop into the supercritical channel.

SUBCRITICAL FLOW CHANNEL

15. A straight subcritical flow channel will extend from the upstream end of the ogee crested structure to the downstream end of the inlet structure from station 62+74 to station 63+74. The channel will be 35 feet wide and have wall heights to 17 feet 8 inches. Concrete thickness will be 2 feet.

INLET STRUCTURE

16. The inlet structure will be constructed from the upstream end of the subcritical channel to station 64+33. The structure will maintain water surface profiles at existing conditions upstream of the channel modification and provide a transition from the riprap trapezoidal channel to the concrete rectangular channel. The structure is just downstream of and tied into a natural restriction to direct flow into the channel and prevent flanking.

DRAINAGE CHANNEL

17. The drainage channel will collect water from two existing 60-inch pipes, increase its velocity, and discharge it into the channel, creating minimal disturbance to the supercritical channel flow. The channel will consist of a drop structure, a transition structure which will change the channel width from 22 feet to 9 feet, approximately 250 feet of 9-foot-wide, 9-foot 6-inch-high rectangular box culvert, and a side inlet spillway which discharges into the channel at station 42+14.

OUTLET A

18. This structure will consist of a flared end section, approximately 800 feet of 60-inch reinforced concrete pipe, a sluice gate well, a flap gate well, two manholes with gated inlets, and an outlet with a safety guard. The outlet discharges in the channel at a 30-degree angle near station 29+00.

ENVIRONMENTAL ANALYSIS

ENVIRONMENTAL SETTING

19. Land use along Chaska Creek consists of residential development, light industrial development, and undeveloped lands. In some areas, the creek is adjacent to a railroad bed or highway. The lower reaches of Chaska Creek pass through the Minnesota Valley National Wildlife Refuge. Vegetation along Chaska Creek is a mix of riparian woods and old field. Riparian woods vegetation includes silver maple (<u>Acer saccharinum</u>), American elm (<u>Ulmus americana</u>), box elder (<u>Acer negundo</u>), cottonwood (<u>populus doltoids</u>), willow (<u>Salix sp.</u>), nettle (<u>Urtica dioica</u>), and grasses. Dominant vegetation of the old field includes staghorn sumac (<u>Rhus glabra</u>), willow, goldenrod (<u>Solidago sp.</u>), and grasses.

IMPACTS

20. Channel construction on Chaska Creek will temporarily disrupt transportation. A detour of Highway 212 at Chaska Creek will be necessary while the diversion channel is begun and a new bridge is constructed. Similarly, construction of the new channel paralleling Chaska Creek at Hickory Street will require detours of neighboring streets while a new bridge over the channel is constructed. A bypass spur for the railroad will be constructed to maintain rail traffic, although some delays in train

schedules may occur at this location. Construction activities will cause short-term increases in noise and air pollution in the area. Approximately 10 acres of riparian woods and 2.5 acres of old field will be lost as a result of channel construction. Habitat losses to wildlife along Chaska Creek will be partially mitigated by the establishment of upland vegetation on project lands. Shrubs and shrubby tree species, such as dogwood, hazel and Russian olive, will be planted. In addition, a variety of native tree species, such as oak, wild plum, chokecherry, maple, and ash will be planted. These areas will be maintained and managed for wildlife purposes. A detailed planting plan for project lands will be designed during the development of plans and specifications. Additional mitigation measures for the Chaska Creek feature and other flood control features at Chaska involve the development of the moist soil unit on the Minnesota Valley National Wildlife Refuge. Details of this mitigation measure will be discussed in the design memorandums for other features of the project.

CULTURAL RESOURCES

21. As required by section 106 of the National Historic Preservation Act of 1966, as amended, the National Register of Historic Places has been consulted. As of July 24, 1984, no sites listed on or determined eligible for the National Register will be affected by the proposed work. In 1980, a literature search, records review, and cultural resources survey failed to locate any archeological or historic resources along Chaska Creek. A cultural resources survey has not been completed for the existing emergency levee which is adjacent to Chaska Creek. It was determined by the Minnesota State Historic Preservation office that a survey was not needed because of the extent of previous disturbance and the limited scope of new construction in this area. Borrow and disposal areas have not yet been identified. When these areas are identified, they will be reviewed for impacts on cultural resources and an assessment of the need for further cultural surveys will be made. Any borrow or disposal areas proposed by a contractor will require approval prior to their use.

SOURCES OF CONSTRUCTION MATERIALS

RIPRAP AND BEDDING

22. Riprap and bedding of adequate quality can be obtained from limestone quarries, developed in the Prairie du Chien Formation, located on the south side of the Minnesota River Valley within 10 miles of Chaska.

CONCRETE AGGREGATE

23. Concrete aggregate of adequate quality can be obtained from continuously operating natural aggregate and crushed rock sources in the Minneapolis-St. Paul, Minnesota, metropolitan area. The project is within 25 to 50 miles of reliable sources in this area. There are sources located within 10 miles of Chaska, but these produce concrete aggregate on an intermittent basis. Although the closer sources have not been tested or used for Corps of Engineers projects, information obtained from the Minnesota Department of Transportation indicates that their material would be adequate as a concrete aggregate.

LEVEE FILL

24. Levee fill will consist of usable material obtained from the channel excavations. If additional fill is needed, a plentiful supply of impervious glacial fill is available from the surrounding uplands.

FREE DRAINING GRANULAR FILL

25. Free-draining granular fill can be obtained commercially from gravel pits located within 15 miles of Chaska.

REAL ESTATE REQUIREMENTS

26. The city of Chaska will be required to provide, without cost to the United States, all permanent and temporary rights-of-way for construction and subsequent maintenance of the levees, channel, drain system, and other appurtenant drainage structures. Further, local interests will be required to provide the rights-of-way for suitable borrow areas, including the right to remove material, and areas for the disposal of all unsuitable materials. The city of Chaska will comply with the provisions of the Uniform Relocation Assistance and Real Property Acquisitions Policy Act of 1970 (Public Law 91-646), to include appraisals; relocation payments; and, for partial takings, a determination as to whether or not the remaining parcel constitutes an uneconomic remnant.

RELOCATIONS

UTILITIES

27. Local interests will make all necessary relocations of utilities in the project area. The utilities are scattered along the project alignment and include electric power, telephone, gas, sanitary sewer, and water lines.

ROADS AND BRIDGES

28. Road raises are required on County State Aid Highway 10 and First Street. As described previously in this report, new bridges are required at First Street, the Chicago and Northwestern Railroad, Hickory Street, and Hillside Drive. The railroad bridge will be constructed with Federal funds; the other bridges will be a local interest cost. Traffic detours will be provided during bridge construction.

COORDINATION

29. During the development of the general design memorandum, considerable coordination was required with the city of Chaska and adjacent landowners. Concerns of the city and landowners regarding methods and scheduling of construction operations will be resolved during preparation of contract plans and specifications and acquisition of necessary rights-of-way. On 16 and 30 October 1984, the city submitted a letter of intent indicating its support of the project and the intention to provide 35 percent of total

project costs (excluding recreation). See appendix E for copies of the pertinent correspondence.

COST ESTIMATE

30. This feature design memorandum estimate of costs is based on October 1984 price levels and reflects recent prices for similar work in the St. Paul District. Table 1 presents a cost estimate comparison for Chaska Creek flood protection between the current approved estimate (PB-3, April 1984) and the revised estimate prepared for this design memorandum. Also shown is an estimate of costs for local cost-sharing based on 35 percent of total project costs. A detailed estimate on Chaska Creek costs is shown in appendix D.

Table 1 - Summary comparison of estimated first costs

Item	Current approved estimate from PB-3, April 1984	Revised estimate this design memo, October 1984 price levels	Local cost sharing,35% October 1984 price levels
Federal first cost			
Construction cost			
Channels	$5,645,000	$6,368,000	$4,674,000
Levees	433,000	379,000	278,000
Relocation	357,000	376,000	276,000
Total construction	6,435,000	7,123,000	5,228,000
Engineering and design	772,000	855,000	628,000
Supervision and administration	450,000	499,000	366,000
Inspection	(193,000)	(214,000)	(157,000)
Overhead	(257,000)	(285,000)	(209,000)
Total Federal first cost	$7,657,000	$8,477,000	6,222,000
Non-Federal first cost			
Lands and damages	550,000	550,000	550,000
Relocations			
Utilities	190,000	175,000	175,000
Roads and bridges	472,000	370,000	370,000
Cash Contribution	0	0	2,255,000
Total non-Federal first cost	1,212,000	1,095,000	3,350,000
Total project costs	$8,869,000	$9,572,000	$9,572,000

The difference in Federal first cost, not including cash contributions, (an increase of $820,000) between this design memorandum cost estimate ($8,477,000) and the current approved estimate from PB-3 dated April 1984 ($7,657,000) is attributable to the following:

a.	Channels	(+)$723,000
	(1) Decrease, change in channel length	(182,000)
	(2) Decrease, refined design of upstream drop structure	(141,000)
	(3) Increase, refined design of appurtenant features, frost protection, shoring, fence, etc.	837,000
	(4) Increase, refined design at Hickory Street diversion	250,000
	(5) Decrease, elimination of service road	(41,000)
b.	Relocations: Increase, refinement in design	19,000
c.	Levees: Decrease, refinement in design	(54,000)
d.	Engineering and design: Increase, direct proportion of estimated construction costs	83,000
e.	Supervision and administration: Same as (d)	49,000

The difference in non-Federal first cost (a decrease of $117,000) between this design memorandum cost estimate ($1,095,000) and the current approved estimate from PB-3 dated April 1984 ($1,212,000) is attributable to refined design and cost estimating.

CURRENT BENEFIT-COST ANALYSIS

31. The benefit-cost ratio for the project at October 1984 price levels, an interest rate of 8 3/8 percent, and assuming traditional cost sharing is presented in table 2.

Table 2 - Benefit-cost ratio

Item	Amount
Federal	
First cost	$20,920,000
Interest during construction	533,200
Total	$21,453,200
Non-Federal	
First cost	3,843,000
Interest during construction	157,700
Total	4,000,700
Average annual charges	
Federal	1,797,300
Non-Federal	335,200
Maintenance, operation, and major replacement	43,900
Total	2,176,400
Average annual benefits	
Flood control	2,457,000
Recreation	29,600
Total	2,486,600
Benefit-cost ratio	1.14

SCHEDULE FOR DESIGN AND CONSTRUCTION

DESIGN

32. Plans and specifications for Stage 1, Chaska Creek, are scheduled for completion in the third quarter of fiscal year 1985.

CONSTRUCTION

33. A continuing contract for Stage 1, Chaska Creek construction, is scheduled to be advertised in May 1986. Construction work should start in July 1986 and continue for about 39 months.

FUNDING SCHEDULE

34. On the basis of the revised estimate for this design memorandum and the current schedule for completion of the project, the Federal funds required (by fiscal year) are:

	Traditional cost-sharing	with local contribution at 35-percent
Funds allocated to date:		
(30 September 1984)	$1,409,000	$1,409,000
Fiscal year 1985	291,000	291,000
1986	2,000,000	1,600,000
1987	5,000,000	3,500,000
1988	6,800,000	5,000,000
1989	5,463,000	4,290,000
Total	$20,963,000	$16,090,000

OPERATION AND MAINTENANCE

35. Local interests will be responsible for the operation and maintenance (O & M) of the project. O & M will consist of periodic inspection and repair as required for the channel, structures, and levee. Instructions will be provided to appropriate local officials for this portion of the project upon completion. This will ensure proper O & M of this stage until completion of the total project.

RECOMMENDATION

I recommend approval of the plan for Stage 1, Chaska Creek of the Chaska, Minnesota, flood control project as presented in this feature design memorandum.

EDWARD G. RAPP
Colonel, Corps of Engineers
District Engineer

HWY 41 BRIDGE REPLACEMENT
BRAND(
CON(
RIPRAP CH
70+
ENGLER BLVD.
GREENBELT / OPEN SPACE
0+00
14+00
EAST CREEK
RAYOUX ROAD
38+00
COUNTY HIGHWAY NO.11
STEPHEN LANE
CHERITA DR.
CROSSTOWN BLVD.
VALLEY VIEW ROAD
CARDINAL ST.
STATE HIGHWAY NO.41
UNDERGROUND CULVERTS
OUTLE
0+(
CHICAGO & NORTHWEST R.R.
STOUGHTON AVE.
BOLDT ST.
CORPORATE LIMITS
COUNTY HIGHWAY NO.10
CHASKA CREEK
DROP STRUCTURE
66+00
HILLSIDE DR.
CHASKA CREEK DIVERSION
56+00
ABANDONED R.R.
ABANDONED
SIXTH ST.
FIFTH
FOURTH
THIRD
SECOND
FIRST
COURTHOUSE LAKE
BEACH
30+00
CO. RD. 140
DRAINAGE CHANNEL
45+00
WEST CR. SERVICE RD.
CHASKA
MAPLE
ASH
OAK
WALNUT
CHESTNUT
PINE
CEDAR
ELM
HICKORY
SPRUCE
LOCUST DR.
MILWAU
OUTLET C
MINNESOTA
PUMPING STATION
U.S. HIGHWAY NO.212
95+00
OUTLET
55+00
29+00
OUTLET B
20+00
CONTROL STRUCTURE
A
B
C
D
E

1

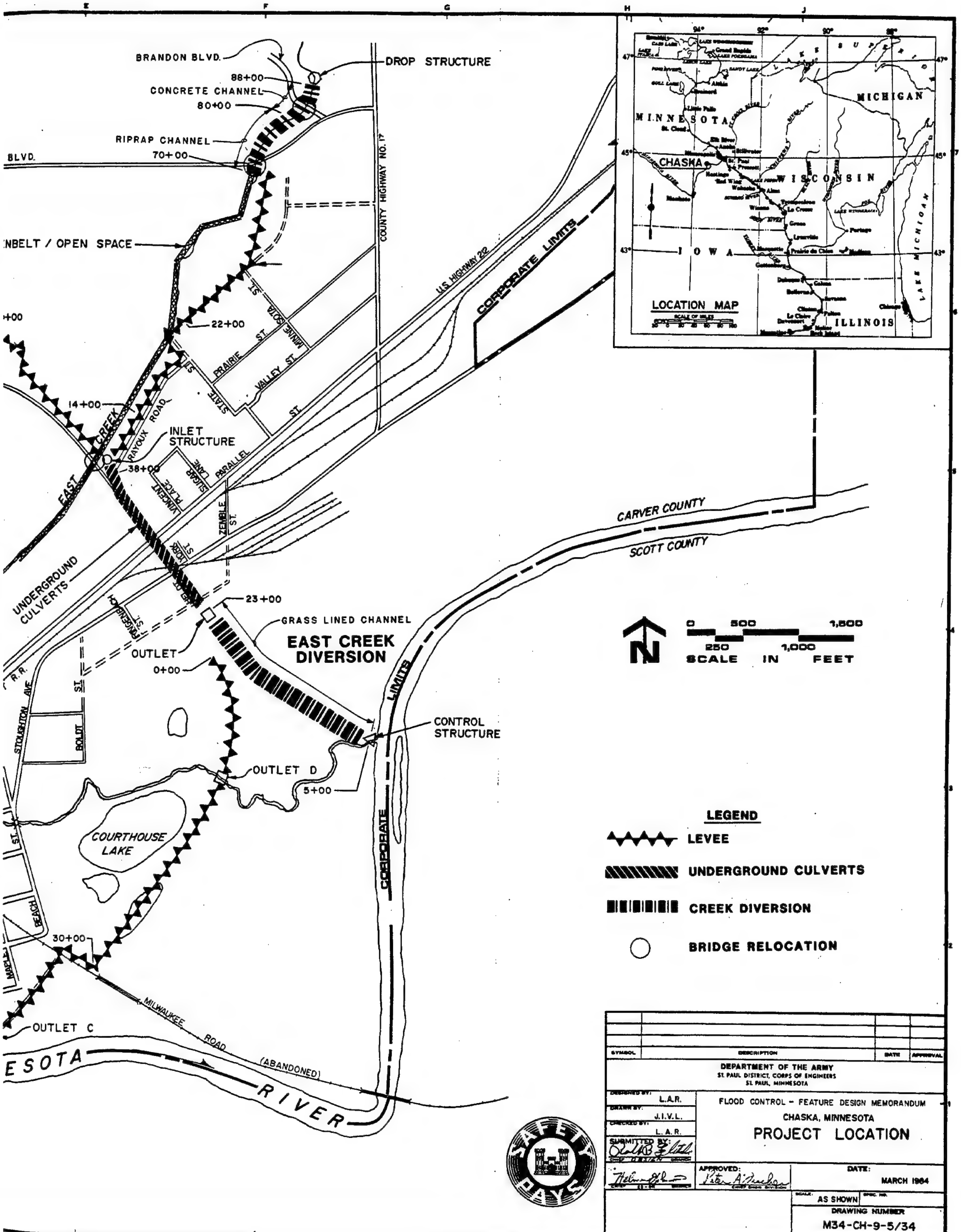
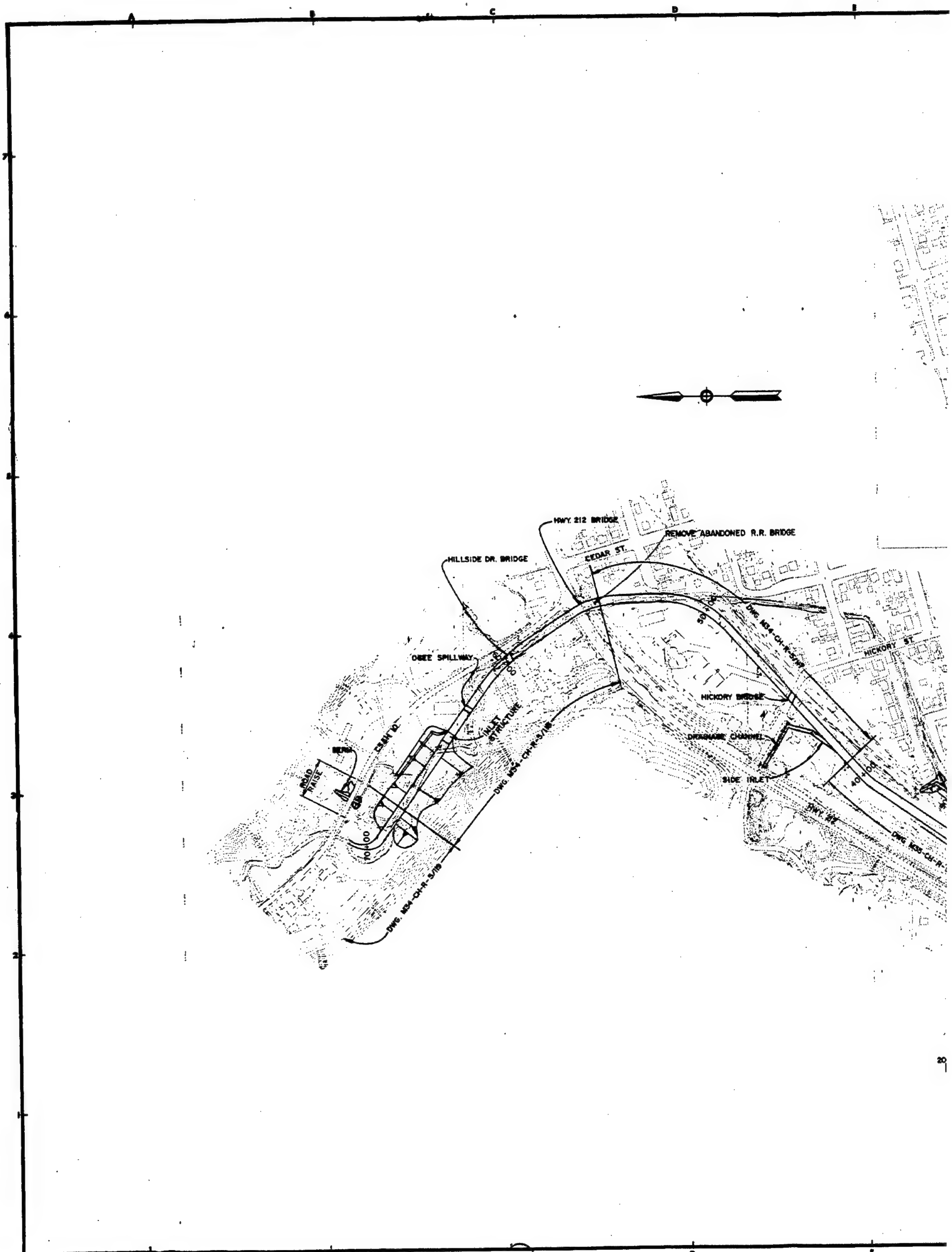

BRANDON BLVD.
DROP STRUCTURE
88+00
CONCRETE CHANNEL
80+00
RIPRAP CHANNEL
70+00
BLVD.
COUNTY HIGHWAY NO. 17
NBELT / OPEN SPACE
U.S. HIGHWAY 212
CORPORATE LIMITS
22+00
MINNESOTA ST.
PRAIRIE ST.
VALLEY ST.
STATE ST.
ST.
14+00
EAST CREEK
RAYOUX ROAD
INLET STRUCTURE
38+00
VINCENT PLACE
SUGAR LANE
PARALLEL
ZEMBLE ST.
YORK ST.
UNDERGROUND CULVERTS
FRINGEHOLM ST.
23+00
GRASS LINED CHANNEL
EAST CREEK DIVERSION
OUTLET
0+00
R.R.
STOUGHTON AVE
ST.
BOLDT
CONTROL STRUCTURE
OUTLET D
5+00
CORPORATE LIMITS
CARVER COUNTY
SCOTT COUNTY
COURTHOUSE LAKE
BEACH
30+00
MAPLE
OUTLET C
MILWAUKEE ROAD (ABANDONED)
ESOTA RIVER
LOCATION MAP
LAKE SUPERIOR
MICHIGAN
MINNESOTA
CHASKA
WISCONSIN
IOWA
ILLINOIS
LAKE MICHIGAN
0 250 500 1,000 1,500
SCALE IN FEET
LEGEND
LEVEE
UNDERGROUND CULVERTS
CREEK DIVERSION
BRIDGE RELOCATION
SYMBOL
DESCRIPTION
DATE
APPROVAL
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
DESIGNED BY: L.A.R.
DRAWN BY: J.I.V.L.
CHECKED BY: L.A.R.
FLOOD CONTROL - FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
PROJECT LOCATION
SUBMITTED BY:
APPROVED:
DATE: MARCH 1984
SCALE: AS SHOWN
DRAWING NUMBER
M34-CH-9-5/34
SAFETY PAYS

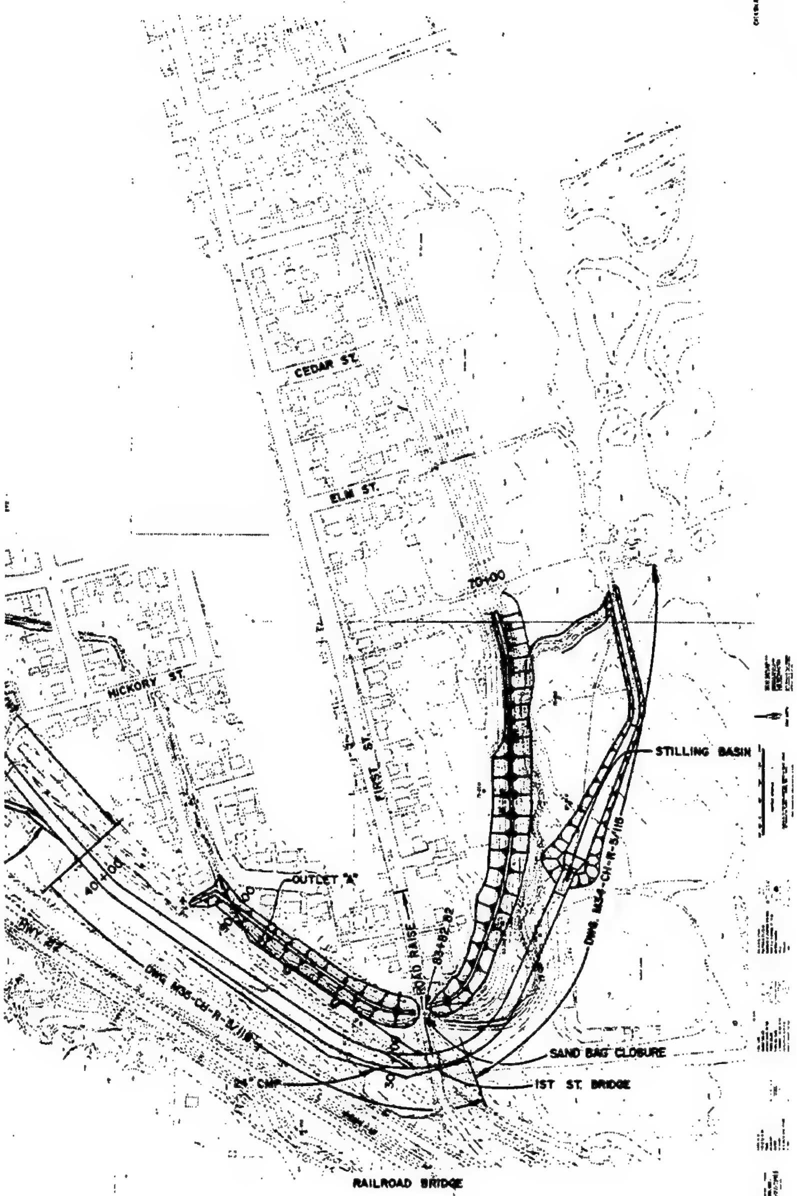
PLATE 1



HWY. 212 BRIDGE
REMOVE ABANDONED R.R. BRIDGE
CEDAR ST.
HILLSIDE DR. BRIDGE
OBEE SPILLWAY
INLET STRUCTURE
BERM
ROAD RAISE
HICKORY ST.
HICKORY BRIDGE
DRAINAGE CHANNEL
SIDE INLET

DRAWING INDEX

PLATE NO.	DRAWING NUMBER	DESCRIPTION
1	M34-CH-R-5/34	LOCATION MAP
2	M34-CH-R-5/114	PROJECT MAP & INDEX
3	M34-CH-R-5/115	CHASKA CREEK PLAN & PROFILE STA.12+00 TO 28+00
4	M34-CH-R-5/116	CHASKA CREEK PLAN & PROFILE STA.28+00 TO 41+00
5	M34-CH-R-5/117	CHASKA CREEK PLAN & PROFILE STA.41+00 TO 55+00
6	M34-CH-R-5/118	CHASKA CREEK PLAN & PROFILE STA.55+00 TO 68+00
7	M34-CH-R-5/119	CHASKA CREEK PLAN & PROFILE STA.68+00 TO 71+30
8	M34-CH-R-5/120	LEVEE IMPROVEMENTS STA. 70+00 TO 83+83
9	M34-CH-R-5/121	LEVEE IMPROVEMENTS STA. 83+82 TO 91+65
10	M34-CH-R-5/123	OUTLET A PLAN & PROFILE
11	M34-CH-R-5/124	OUTLET A PLANS AND SECTIONS
12	M34-CH-R-5/125	CSAH 10 DETAILS & SECTIONS
13	M34-CH-R-5/126	LEVEE SECTIONS & TRASH GUARD
14	M34-CH-R-5/127	CHANNEL SECTIONS
15	M34-CH-R-5/128	CHANNEL SECTIONS
16	M34-CH-R-5/129	CHANNEL SECTIONS
17	M34-CH-R-5/130	CHANNEL SECTIONS
18	M34-CH-R-5/131	STILLING BASIN
19	M34-CH-R-5/132	TYPICAL CHANNEL SECTIONS
20	M34-CH-R-5/133	OGEE SPILLWAY & CHANNEL SECTIONS
21	M34-CH-R-5/134	INLET STRUCTURE
22	M34-CH-R-5/135	DRAINAGE CHANNEL SIDE INLET
23	M34-CH-R-5/136	DRAINAGE CHANNEL DROP STRUCTURE
24	M34-CH-R-5/137	RAILROAD/1ST STREET BRIDGE
25	M34-CH-R-5/138	RAILROAD/1ST STREET BRIDGE
26	M34-CH-R-5/139	HICKORY STREET BRIDGE
27	M34-CH-R-5/140	HILLSIDE DRIVE BRIDGE
28	M34-CH-R-5/141	DETAILS



200 100 0 200 400
SCALE

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: L.A.R.
DRAWN BY: J.H.M.
CHECKED BY: C.P.S. & M.A.M.
SUBMITTED BY:

FLOOD CONTROL — FEATURE DESIGN MEMORANDUM

CHASKA, MINNESOTA
CHASKA CREEK
PROJECT MAP & INDEX

APPROVED:

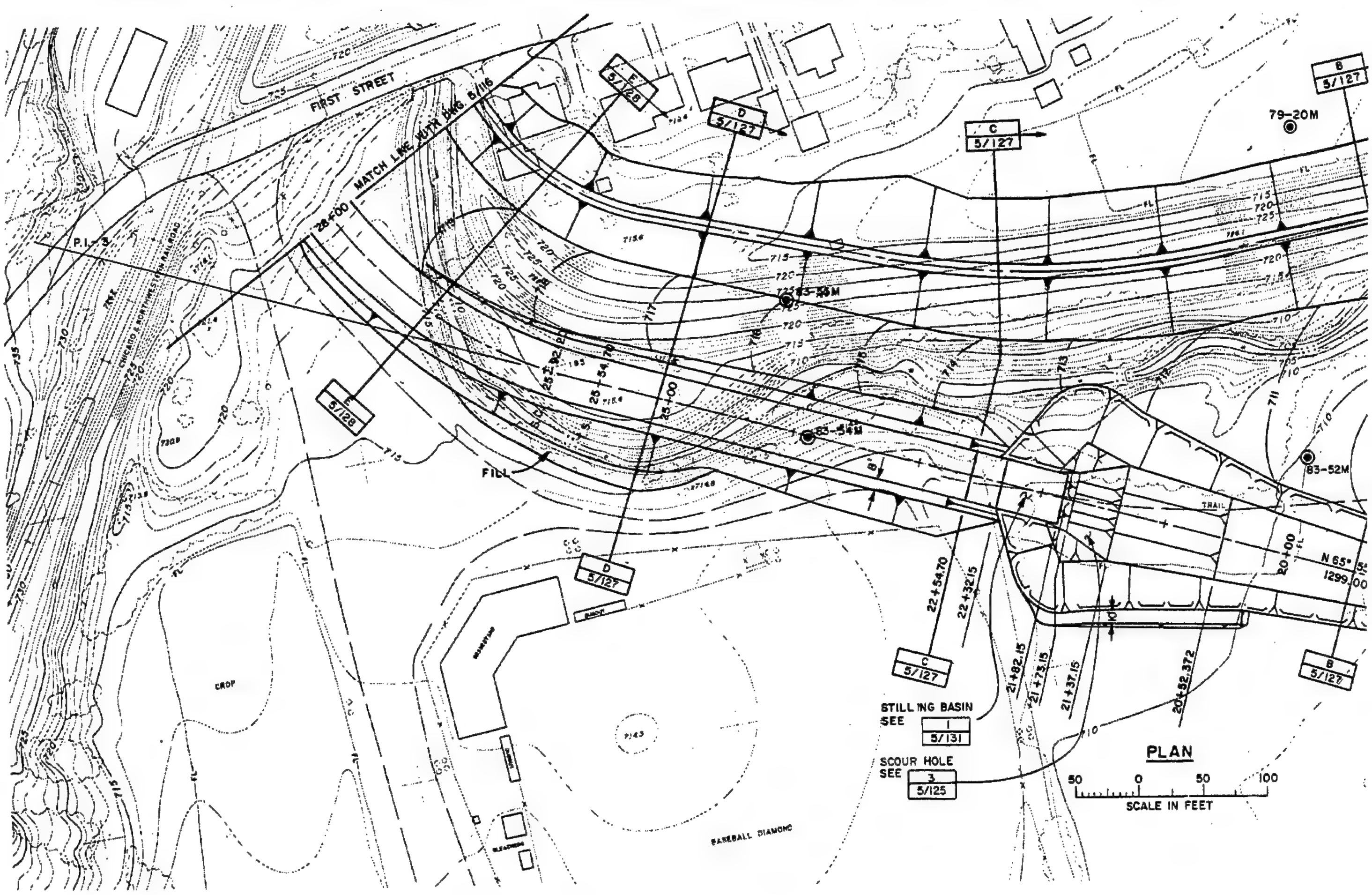
DATE: OCTOBER 1984

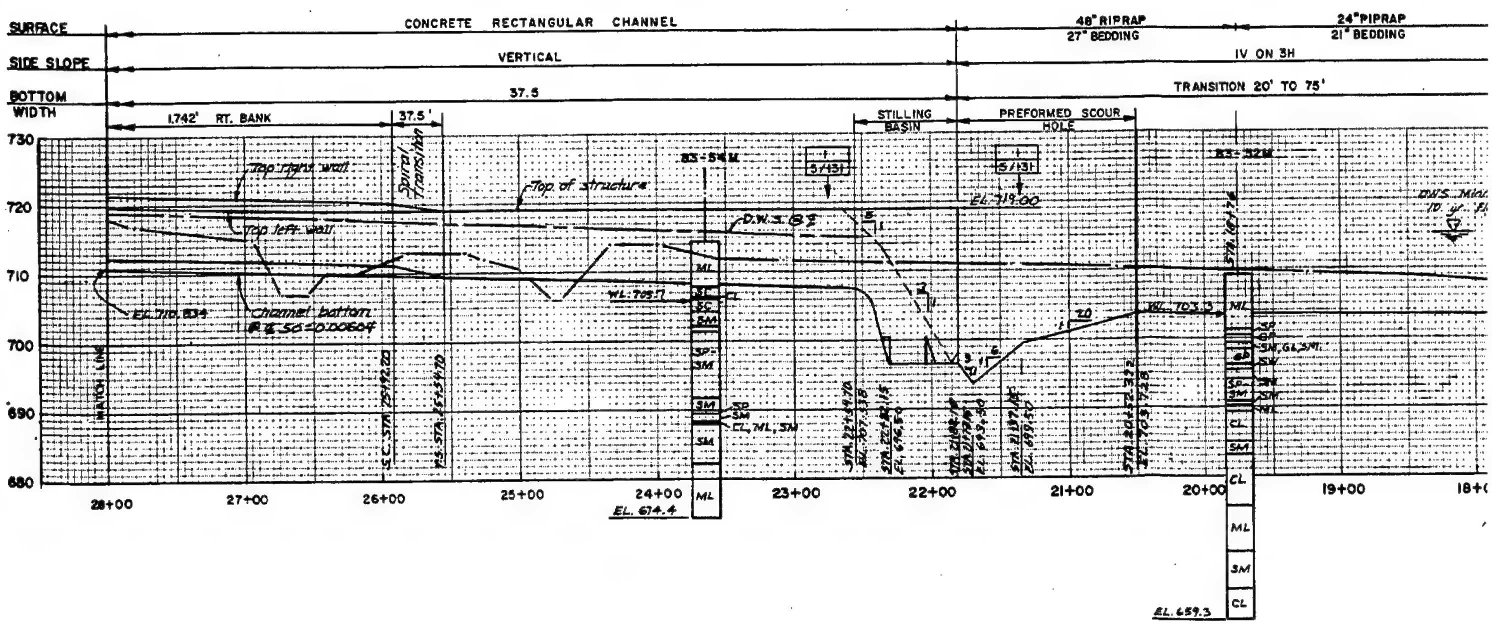
SCALE: AS SHOWN

DRAWING NUMBER
M34-CH-R-5/114
SHEET OF

PLATE 2

2


FIRST STREET
MATCH LINE WITH DWG. 5/116
28+00
P.I.-3
FILL
STILLING BASIN SEE 1 5/131
SCOUR HOLE SEE 3 5/125
PLAN
SCALE IN FEET
79-20M
83-52M
BASEBALL DIAMOND
TRAIL
22+54.70
22+32.15
21+82.15
21+73.15
21+37.15
20+52.372
N 65°
1299.00


SURFACE
CONCRETE RECTANGULAR CHANNEL
48" RIPRAP
27" BEDDING
24" RIPRAP
21" BEDDING
SIDE SLOPE
VERTICAL
1V ON 3H
BOTTOM WIDTH
37.5
TRANSITION 20' TO 75'
1.742' RT. BANK
37.5'
STILLING BASIN
PREFORMED SCOUR HOLE
83-54M
83-52M
Top right wall
Top left wall
Top of structure
Spiral Transition
EL. 719.00
EL. 710.834
Channel bottom
WL: 705.7
WL: 703.3
MATCH LINE
EL. 674.4
EL. 659.3
28+00
27+00
26+00
25+00
24+00
23+00
22+00
21+00
20+00
19+00

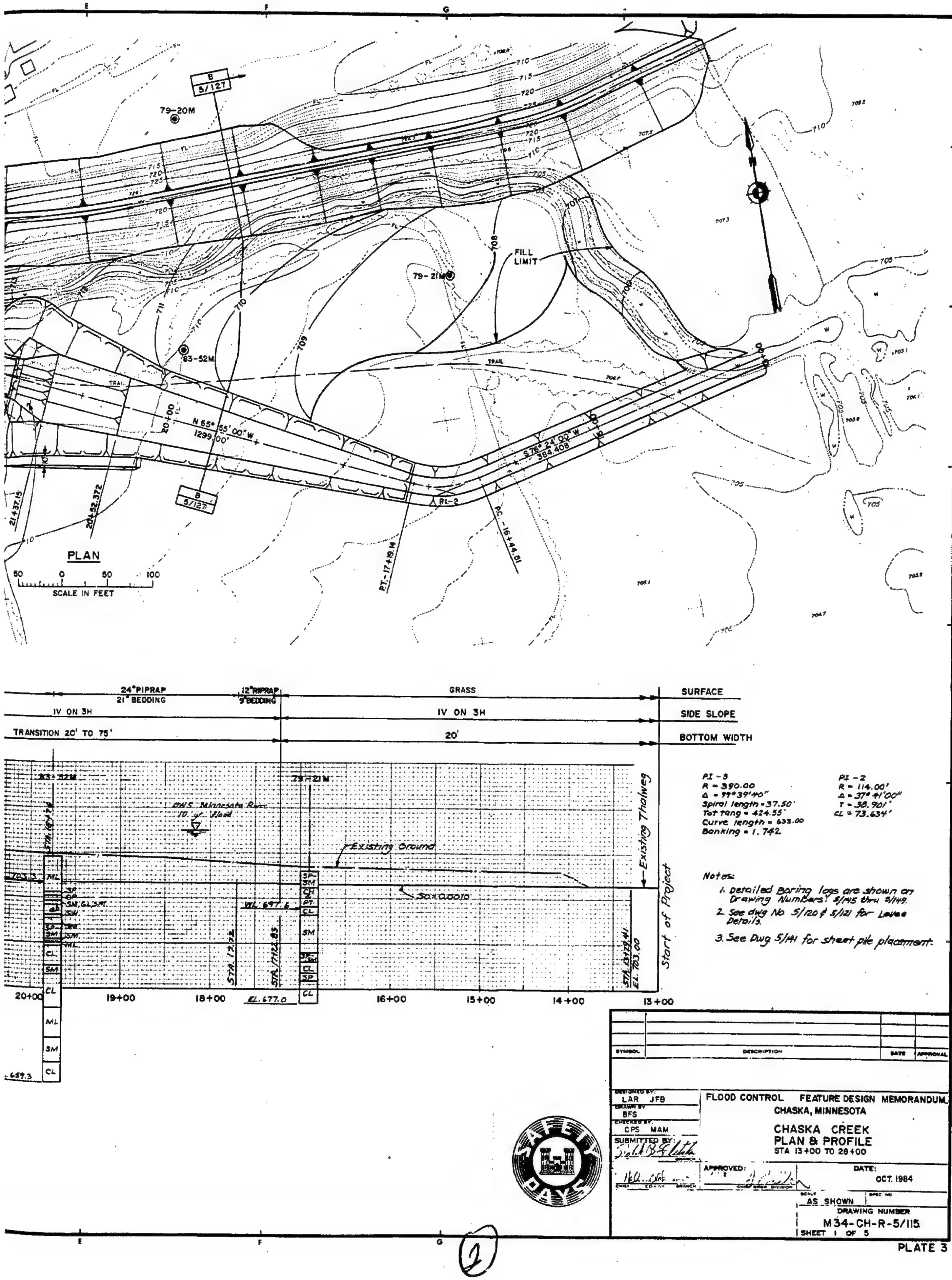
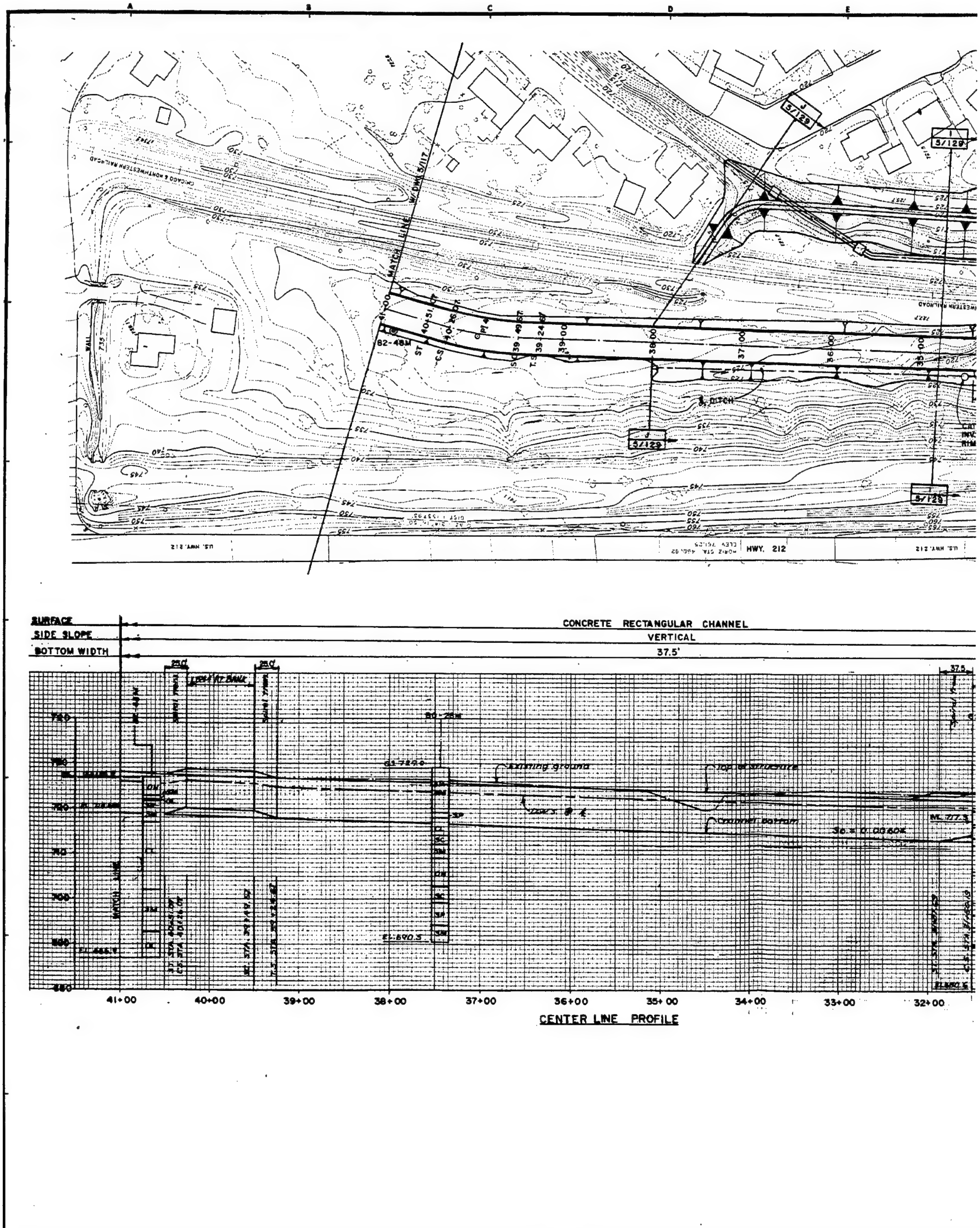
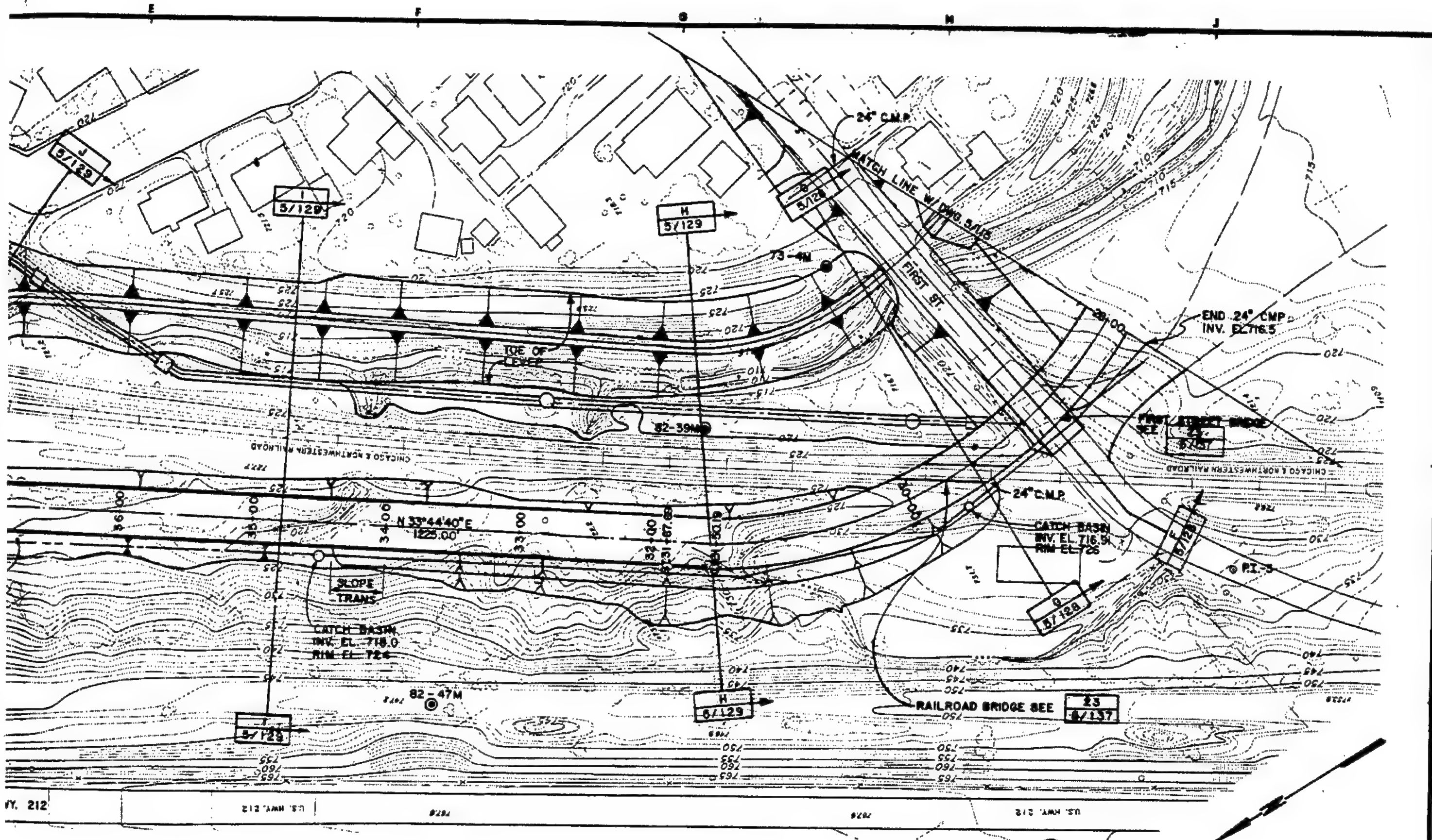

PLAN
SCALE IN FEET
79-20M
79-21M
83-52M
FILL LIMIT
TRAIL
N 65° 55' 00" W 1299.00'
S 76° 24' 00" W 384.408
PI-2
PT-17+19.14
PC-16+44.51
24" RIPRAP 21" BEDDING
12" RIPRAP 9" BEDDING
GRASS
SURFACE
IV ON 3H
SIDE SLOPE
TRANSITION 20' TO 75'
20'
BOTTOM WIDTH
DHS Minnesota River 10 yr. flood
Existing Ground
Existing Thalweg
Start of Project
S0=0.0010
WL 697.6
EL. 677.0
STA. 13+39.41 EL. 703.00
20+00
19+00
18+00
16+00
15+00
14+00
13+00
PI-3
R = 390.00
Δ = 99°39'40"
Spiral length = 37.50'
Tot tang = 424.55'
Curve length = 633.00
Banking = 1.742
PI-2
R = 114.00'
Δ = 37° 41' 00"
T = 38.901'
CL = 73.634'
Notes:
1. Detailed Boring logs are shown on Drawing Numbers: 5/145 thru 5/149.
2. See dwg No. 5/120 & 5/121 for Levee Details.
3. See Dwg 5/141 for sheet pile placement.
SYMBOL
DESCRIPTION
DATE
APPROVAL
DESIGNED BY: LAR JFB
DRAWN BY: BFS
CHECKED BY: CPS MAM
SUBMITTED BY:
APPROVED:
FLOOD CONTROL FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
CHASKA CREEK
PLAN & PROFILE
STA 13+00 TO 28+00
DATE: OCT. 1984
SCALE: AS SHOWN
DRAWING NUMBER
M34-CH-R-5/115
SHEET 1 OF 5
SAFETY PAYS

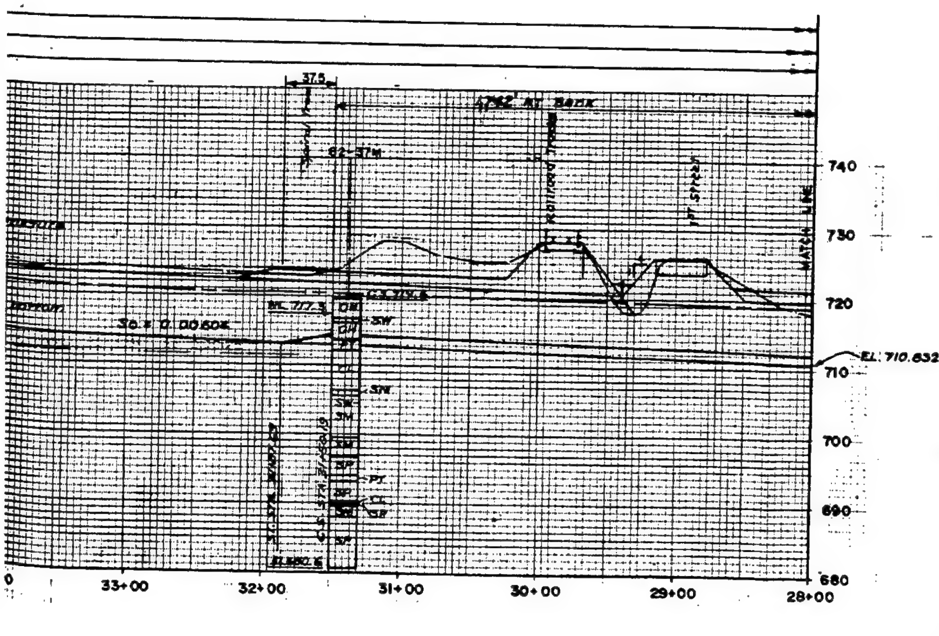
PLATE 3



A
B
C
D
E
MATCH LINE W/DWG 5/117
CHICAGO & NORTHWESTERN RAILROAD
WALL
5/129
82-48M
HWY. 212
U.S. HWY. 212
41+00
38+00
37+00
36+00
35+00
DITCH
SURFACE
SIDE SLOPE
BOTTOM WIDTH
CONCRETE RECTANGULAR CHANNEL
VERTICAL
37.5'
existing ground
top of structure
channel bottom
MATCH LINE
41+00
40+00
39+00
38+00
37+00
36+00
35+00
34+00
33+00
32+00
CENTER LINE PROFILE

1





PI - 4
R = 410.00'
Δ = 14°10'10"
Spiral length = 25'
Tot tang = 63.47'
Curve length = 126.40'
Banking = 1.5'

Notes:

1. *Detailed boring logs are shown on Drawing Numbers: 5/145 thru 149*
2. *See Dwg. 5/20 & 5/21 for Levee Details*
3. *See Dwg. 5/123 for Outlet "A" Details*
4. *See Dwg. 5/141 for Sheet Pile Placement*

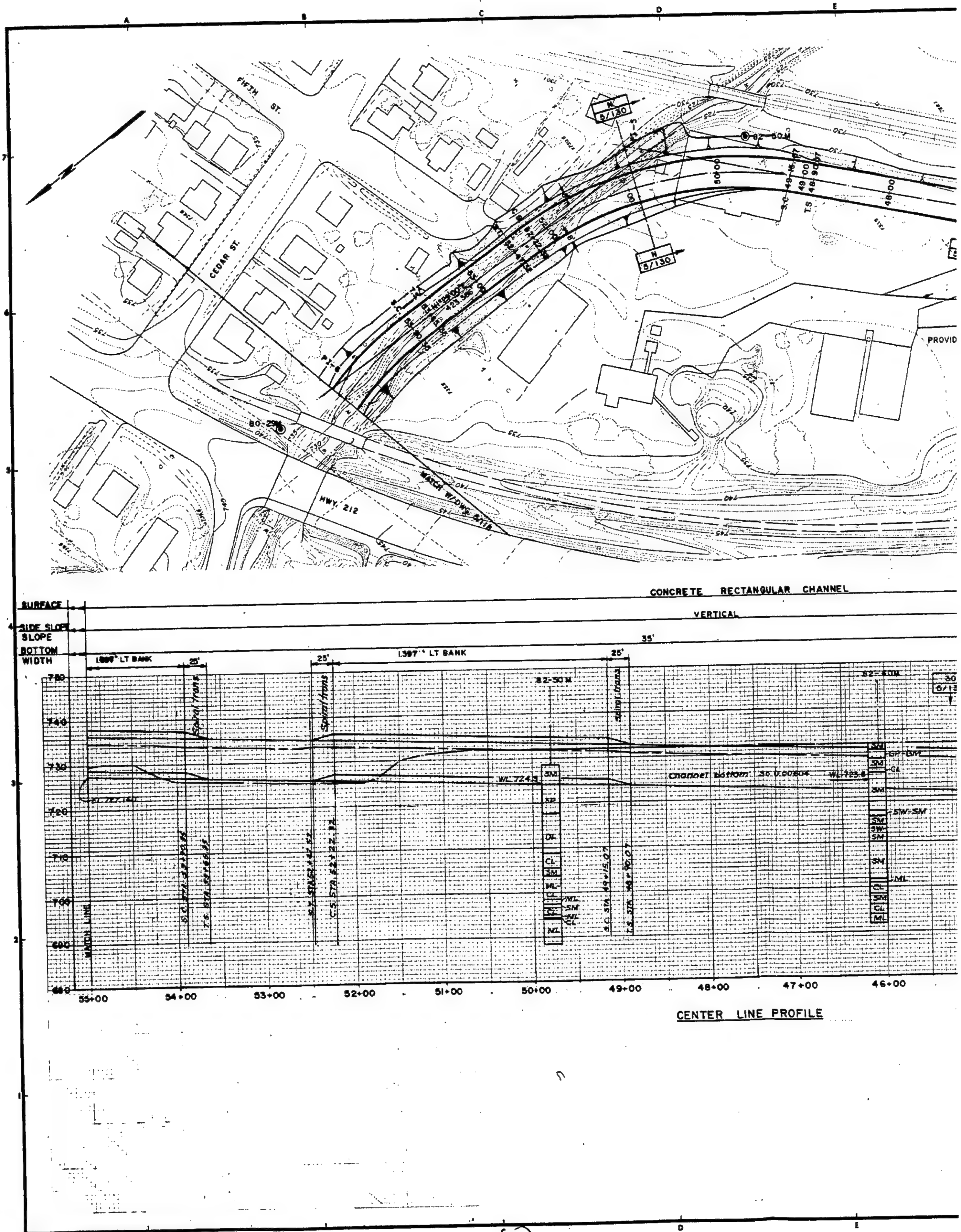
SYMBOL	DESCRIPTION	DATE	APPROVAL

DESIGNED BY: LAR. JFB
DRAWN BY: BFS
CHECKED BY: M.A.M. C.R.S.
SUBMITTED BY:

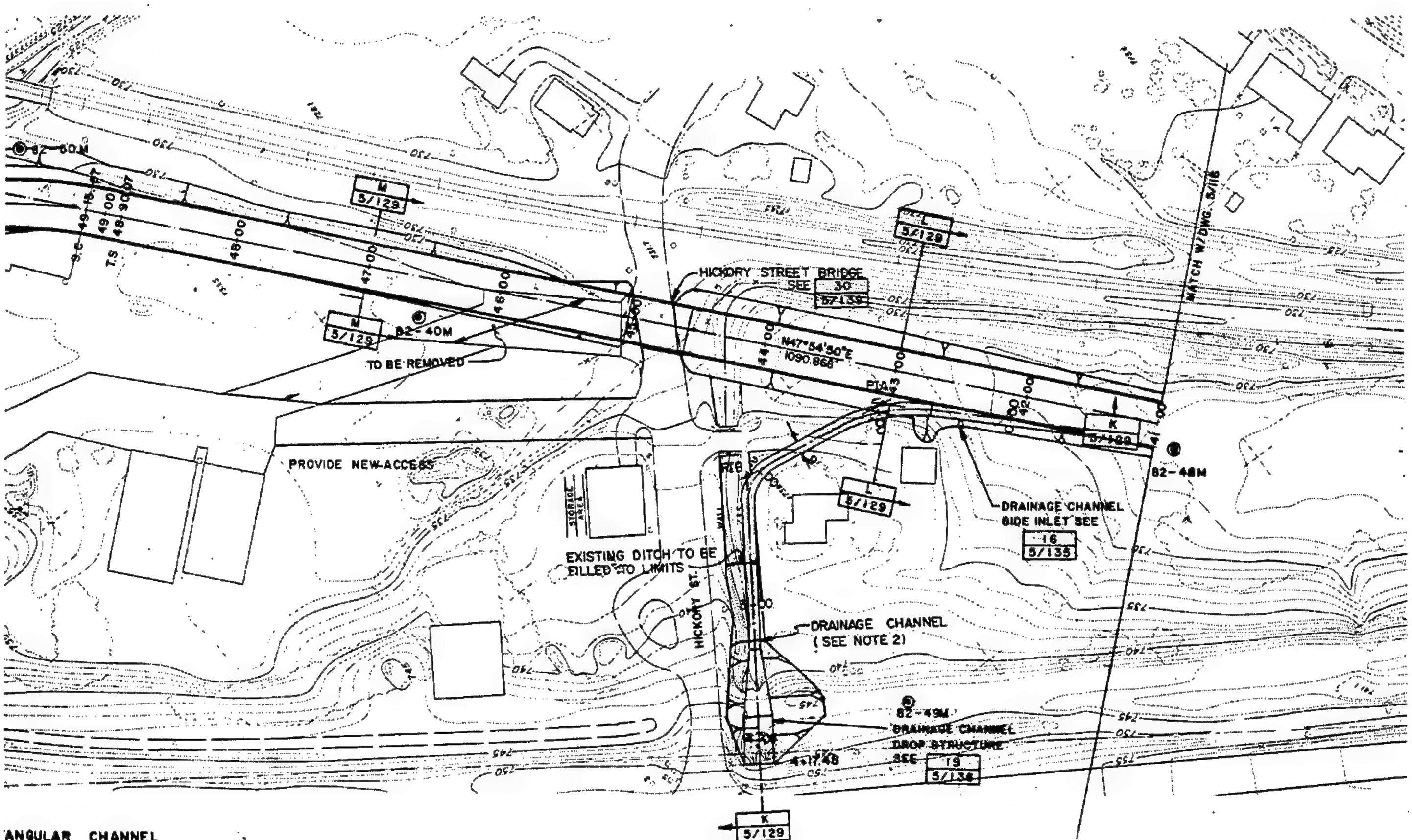
FLOOD CONTROL FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
CHASKA CREEK
PLAN & PROFILE
STA 28+00 TO 41+00

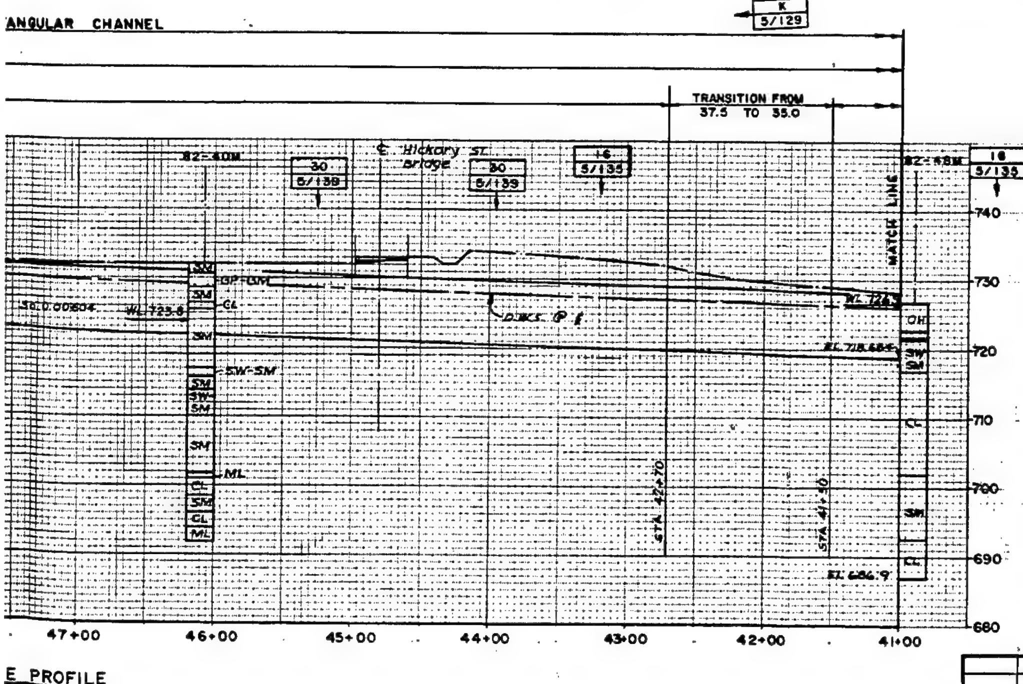
APPROVED:
DATE: OCT. 1984
SCALE: AS SHOWN
DRAWING NUMBER M34-CH-R-5/116
SHEET 2 OF 5

PLATE 4



FIFTH ST.
CEDAR ST.
HWY. 212
MATCH W/DWG. 5/118
N
5/130
82-50M
80-29M
PROVID
CONCRETE RECTANGULAR CHANNEL
VERTICAL
35'
SURFACE
SIDE SLOPE
SLOPE
BOTTOM
WIDTH
LT BANK
1,397± LT BANK
25'
Spiral trans
82-50M
82-60M
WL 724.3
Channel bottom
WL 723.8
MATCH LINE
SM
SP
OL
CL
ML
GP-GM
SW-SM
750
740
730
720
710
700
690
680
55+00
54+00
53+00
52+00
51+00
50+00
49+00
48+00
47+00
46+00
CENTER LINE PROFILE





PI - 5
R = 410.00'
Δ = 46°25'50"
Spiral length = 25'
Tot tang = 188.40'
Curve length = 357.25
Banking = 1.897'

PI-A
R = 120.00'
Δ = 34°41'41"
T = 37.485'
L = 72.665'
PC = 0+59.412
PI = 0+96.897
PT = 1+32.077

PI - B
R = 30.00'
Δ = 65°8'38"
T = 19.245'
L = 34.223'
PC = 1+89.772
PI = 2+09.017
PT = 2+23.994

Notes:

1. Detailed boring logs are shown on Drawing Numbers: 5/143 thru 149
2. For Profile and Details of Drainage Channel see drawing No. M34-CH-R-5/129 Section K
3. See dwg. 5/141 for Sheet Pile Placement

SYMBOL	DESCRIPTION	DATE	APPROVAL

DESIGNED BY: LAR JFB
DRAWN BY: BFS
CHECKED BY: CPS MAM
SUBMITTED BY:
APPROVED:

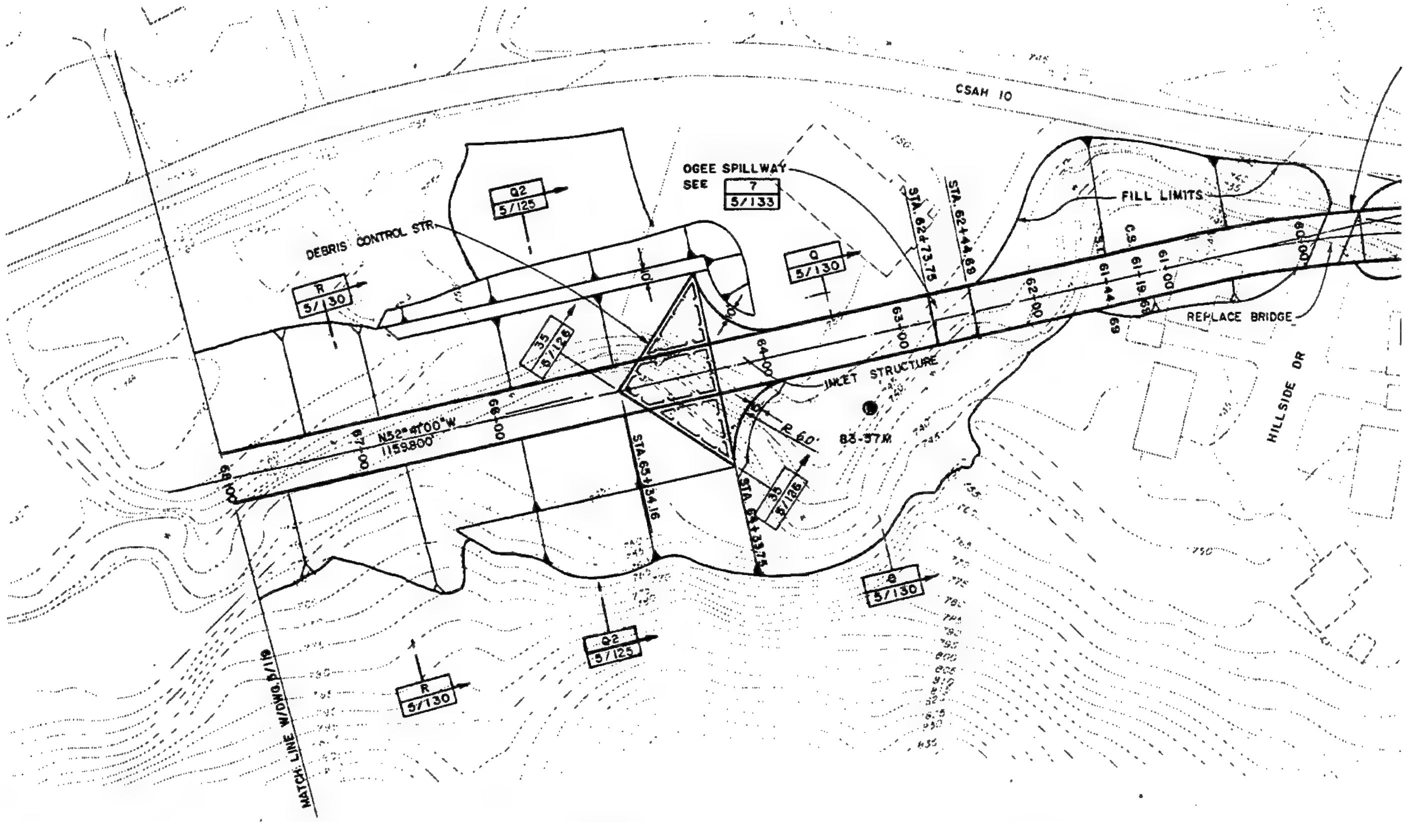
FLOOD CONTROL FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
CHASKA CREEK
PLAN & PROFILE
STA 41+00 TO 55+00

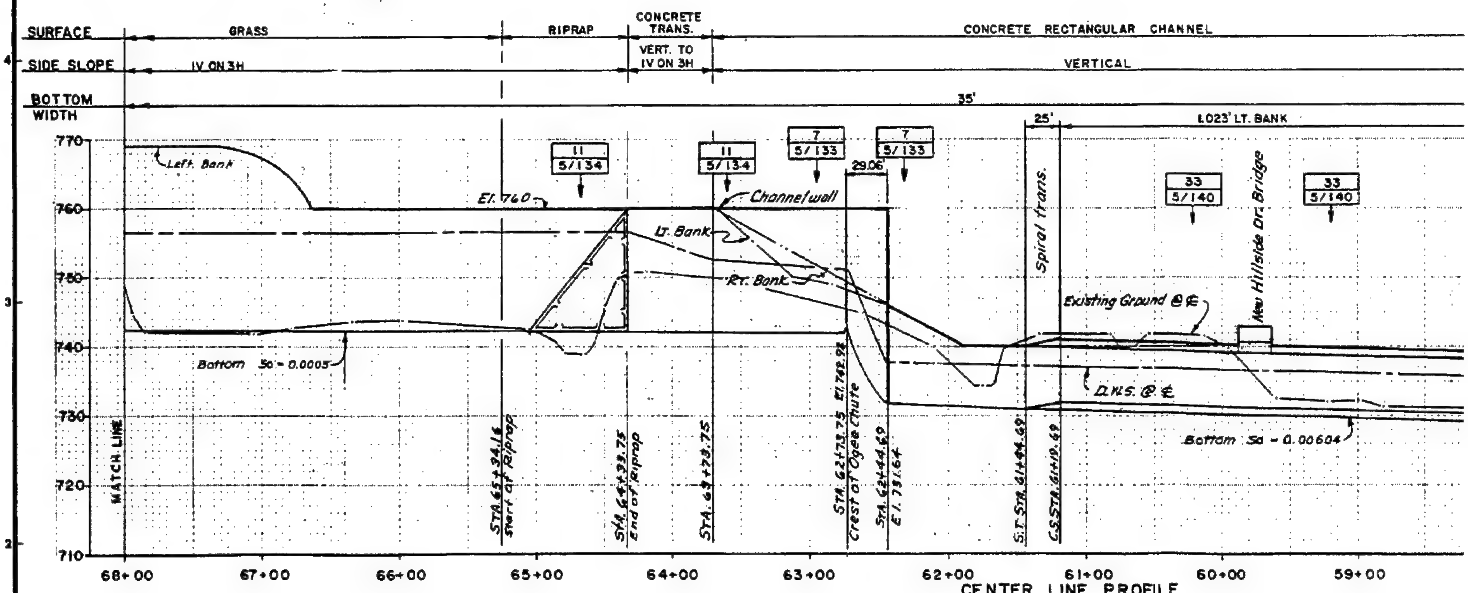
DATE: OCTOBER 1984
SCALE: AS SHOWN
DRAWING NUMBER M34-CH-R-5/117
SHEET 3 OF 5

SAFETY PAYS

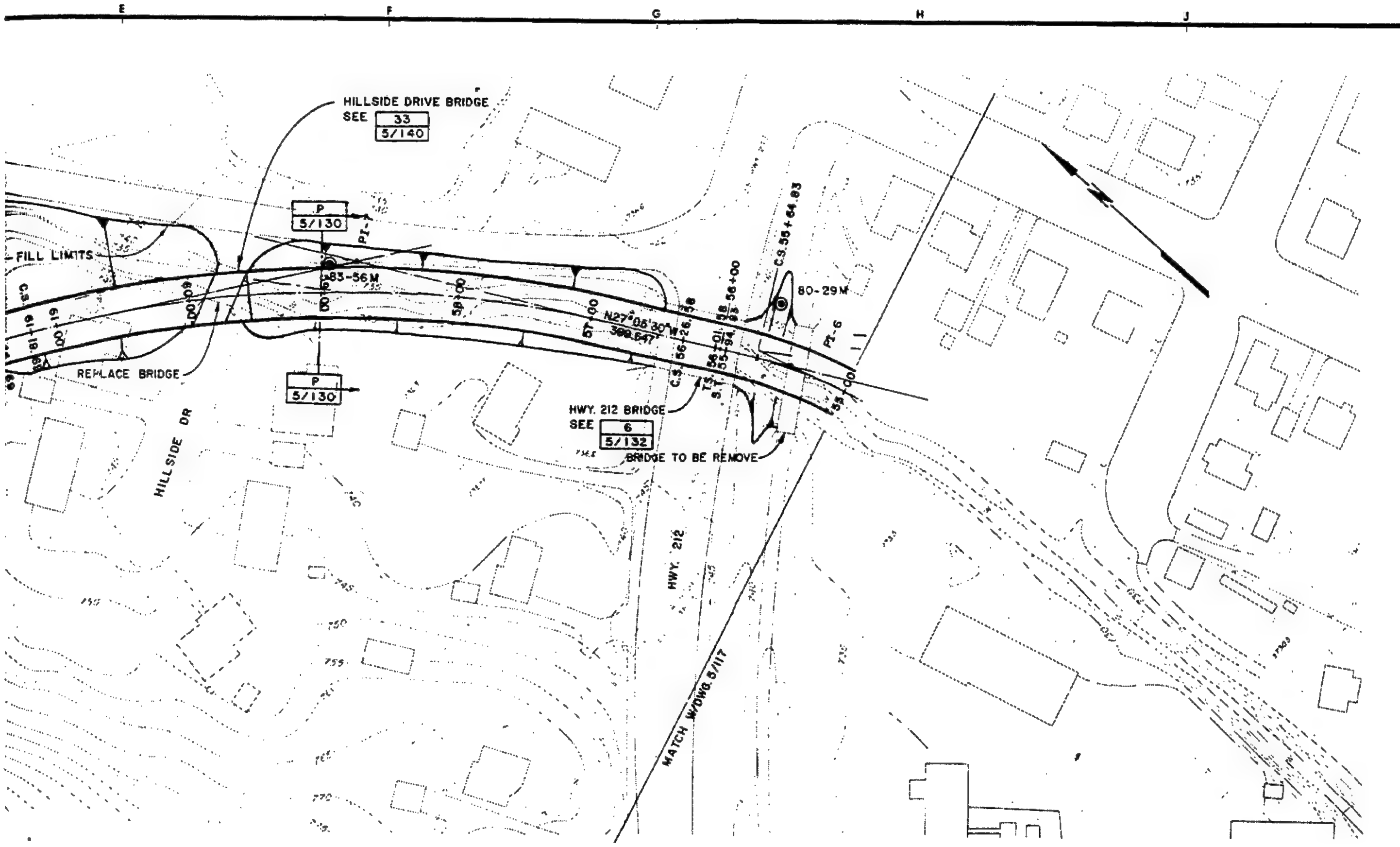
PLATE 5

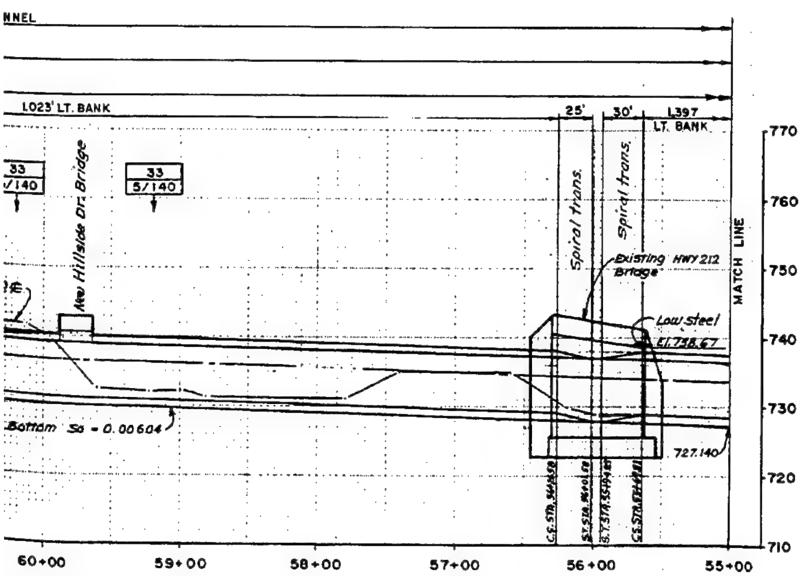
(2)





CENTER LINE PROFILE





PI – 7
R = 1160.00'
Δ = 25°35'30"
Spiral length = 25'
Tot Tang = 275.96
Curve length = 543.11
Banking = 1.023

PI – 6
R = 410.00'
Δ = 28°34' 30"
Spiral length = 25'
Tot tang = 116.94'
Curve length = 229.48'
Banking = 1.397'

Notes:

1. Detailed boring logs are shown on Drawing Numbers: 5/145 thru 149
2. Highway 212 Bridge design H.W. EL. 737.7 low steel EL. 738.67.
3. See Dwg. 5/141 for sheet pile placement

SYMBOL	DESCRIPTION	DATE	APPROVAL

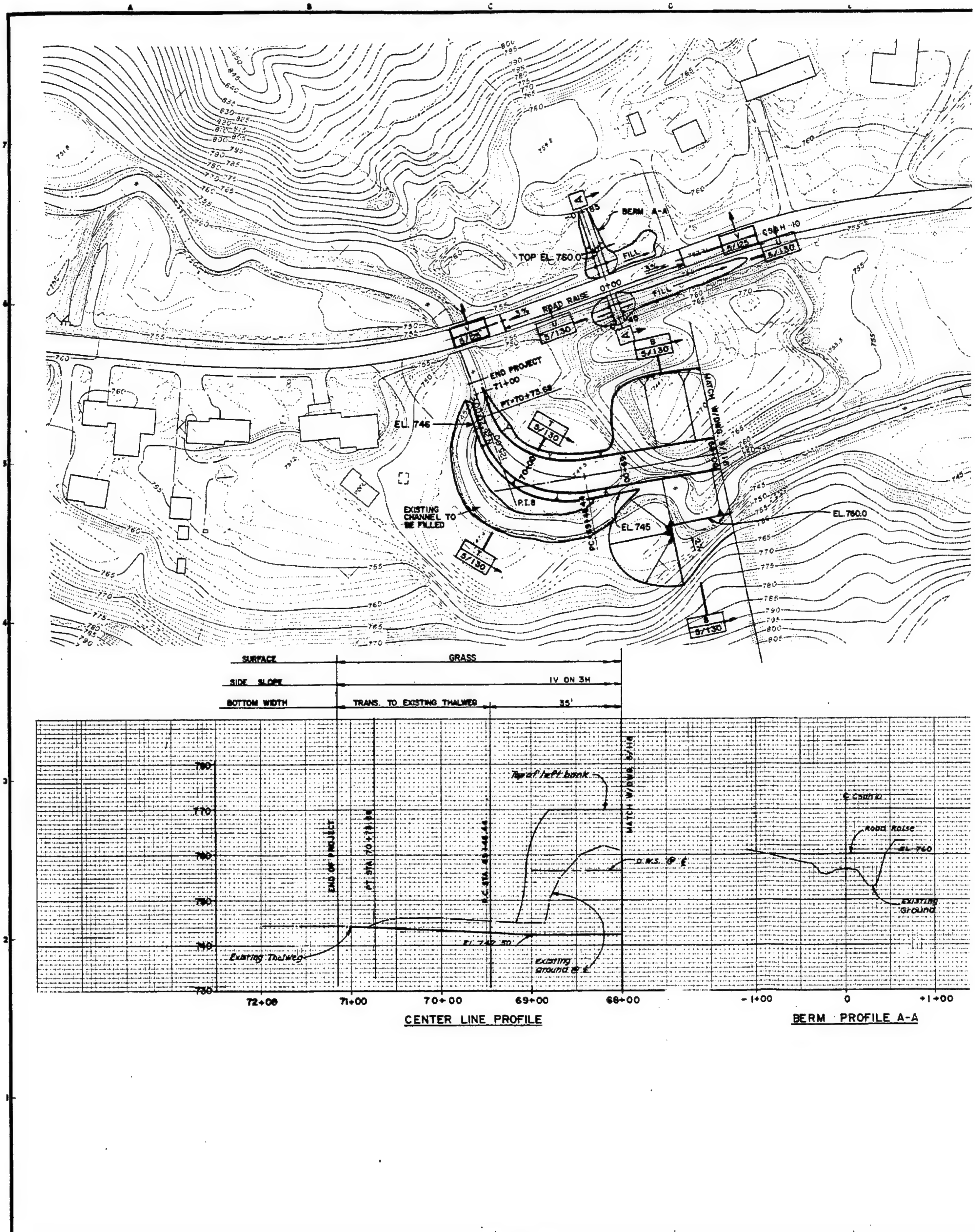
DESIGNED BY: LAR JFB
DRAWN BY: BFS
CHECKED BY: CPS MAM
SUBMITTED BY:

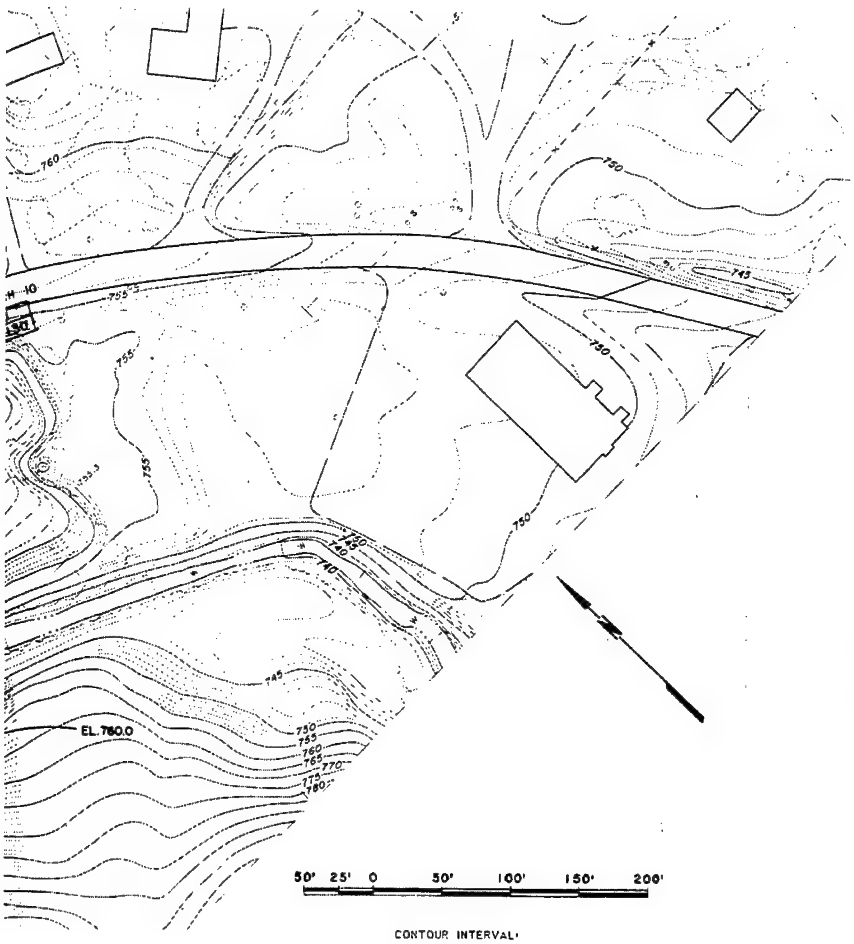
FLOOD CONTROL FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
CHASKA CREEK
PLAN & PROFILE
STA 55+00 TO 68+00

APPROVED:
DATE: OCTOBER 1984
SCALE: AS SHOWN
DRAWING NUMBER: M34-CH-R-5/118
SHEET 4 OF 5

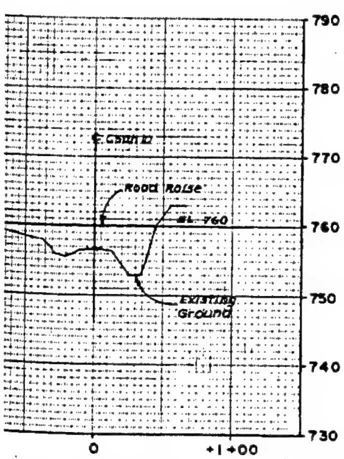
PLATE 6

8


BERM A-A
TOP EL. 760.0
FILL
ROAD RAISE 0+00
CSAH 10
END PROJECT 71+00
PT 70+73.68
EL. 746
EXISTING CHANNEL TO BE FILLED
P.I. 8
EL. 745
EL. 760.0
MATCH W/DWG. 5/110
SURFACE
GRASS
SIDE SLOPE
1V ON 3H
BOTTOM WIDTH
TRANS. TO EXISTING THALWEG
35'
END OF PROJECT
PT STA. 70+73.68
Top of left bank
D.W.S. @ ℄
Existing Thalweg
Existing ground @ ℄
℄ CSAH 10
Road Raise
EL-760
Existing Ground
72+00
71+00
70+00
69+00
68+00
-1+00
0
+1+00
CENTER LINE PROFILE
BERM PROFILE A-A



P.I. = 8
R = 100.00'
Δ = 79°01'00"
T = 83.458'
L = 137.299



BERM PROFILE A-A

SYMBOL	DESCRIPTION	DATE	APPROVAL

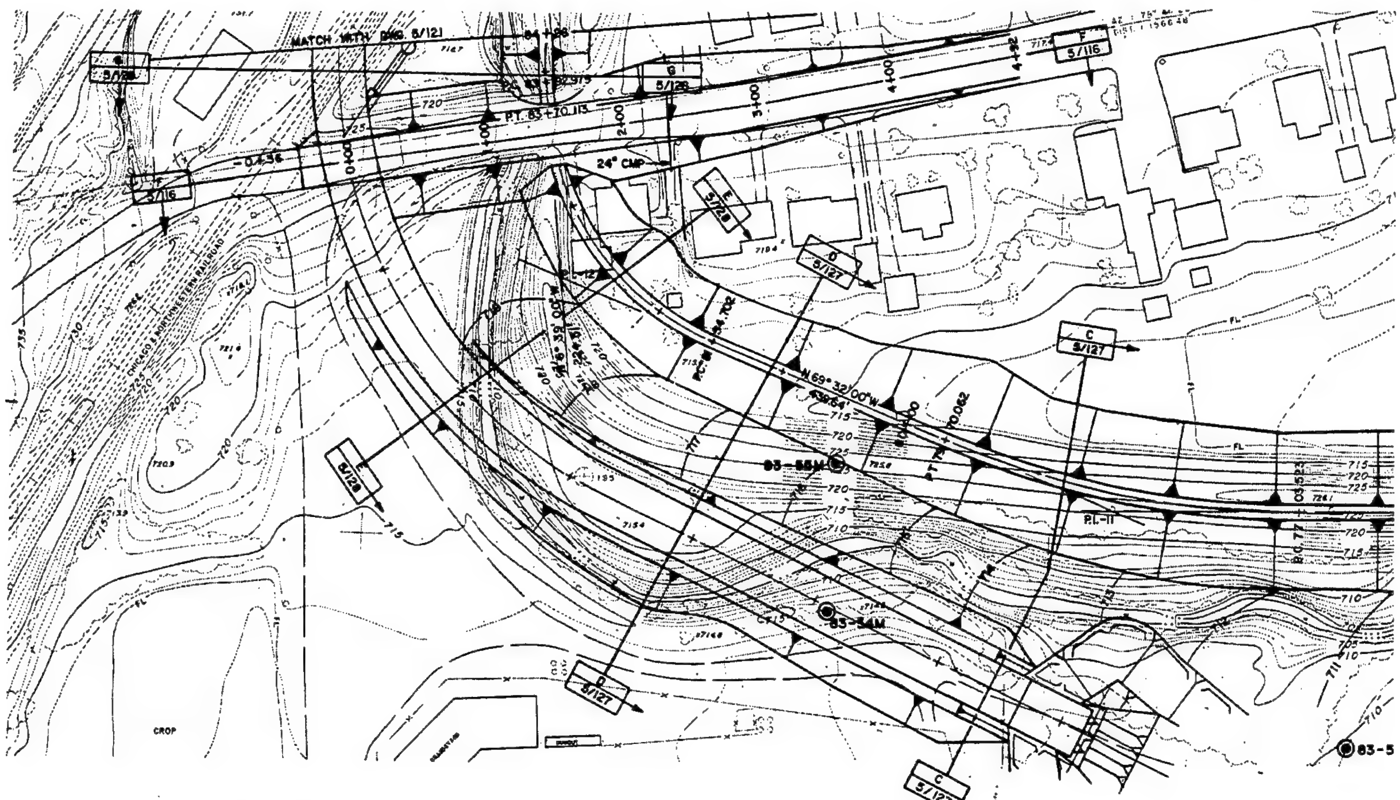
DESIGNED BY: L.A.R. J.F.B.
DRAWN BY: J.M.J. B.F.S.
CHECKED BY: C.P.S., M.A.M.
SUBMITTED BY:

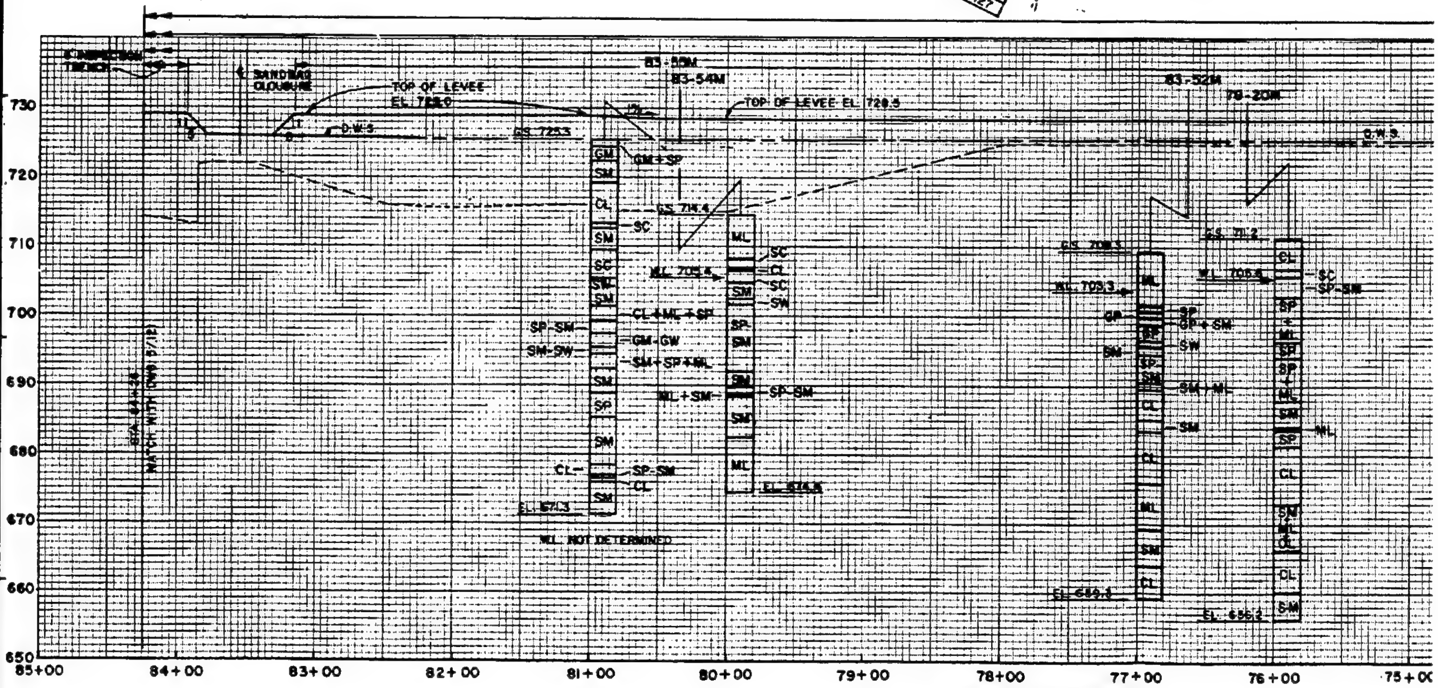
FLOOD CONTROL FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
CHASKA CREEK
PLAN AND PROFILE
STA 68+00 TO 71+30

APPROVED:

DATE: OCTOBER 1984
SCALE: AS SHOWN
DRAWING NUMBER M34-CH-R-5/119
SHEET 5 OF 5

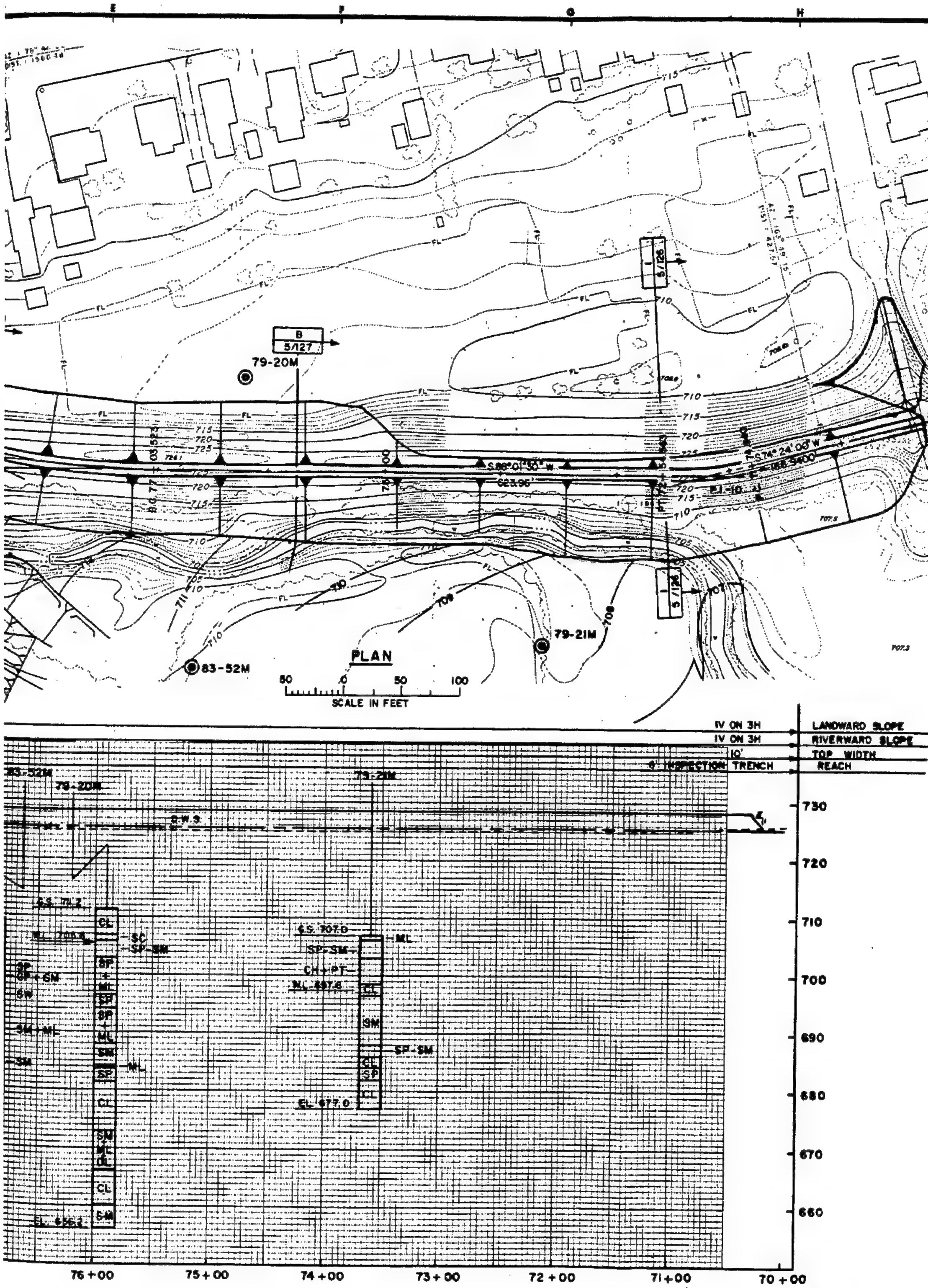
PLATE 7





CENTER LINE PROFILE

1



P.I. 10

R = 334.829
Δ = 13° 37' 30"
T = 40.00
P.C. = 71 + 74.940
P.I. = 72 + 14.940
P.T. = 72 + 54.663

P.I. 11

R = 680.801
Δ = 22° 26' 30"
T = 135.00'
P.C. = 77+03.623
P.I. = 78+ 38.623
P.T. = 79 + 70.062

P.I. 12

R = 196.270
Δ = 62° 53' 00"
T = 120.00'
P.C. = 81 + 54.702
P.I. = 82 + 74.702
P.T. = 83 + 70.113

NOTES:

1. SEE DWG. NO. 5/115 FOR CHANNEL DETAILS.
2. INSPECTION TRENCH REQUIRED THIS REACH.

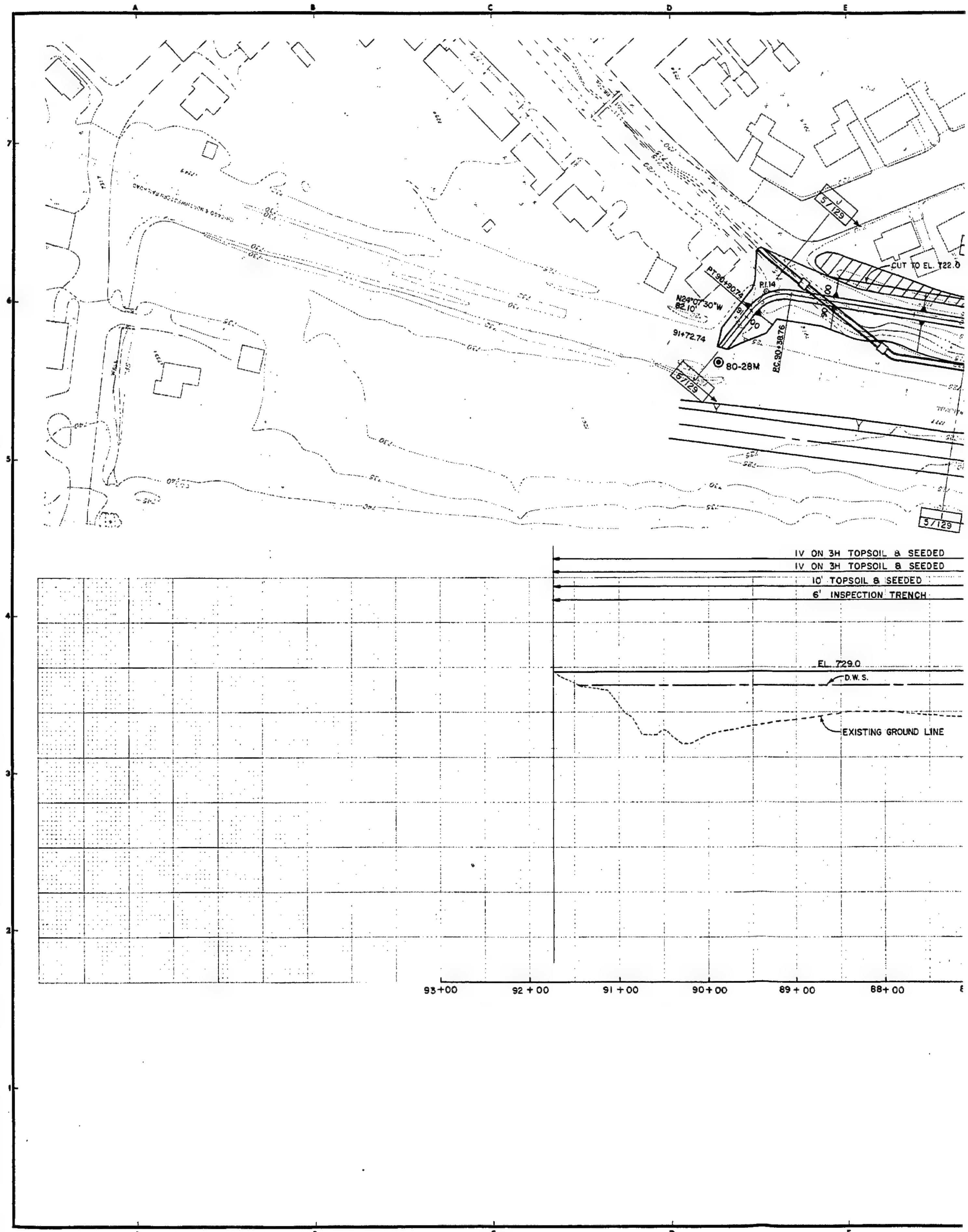
SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

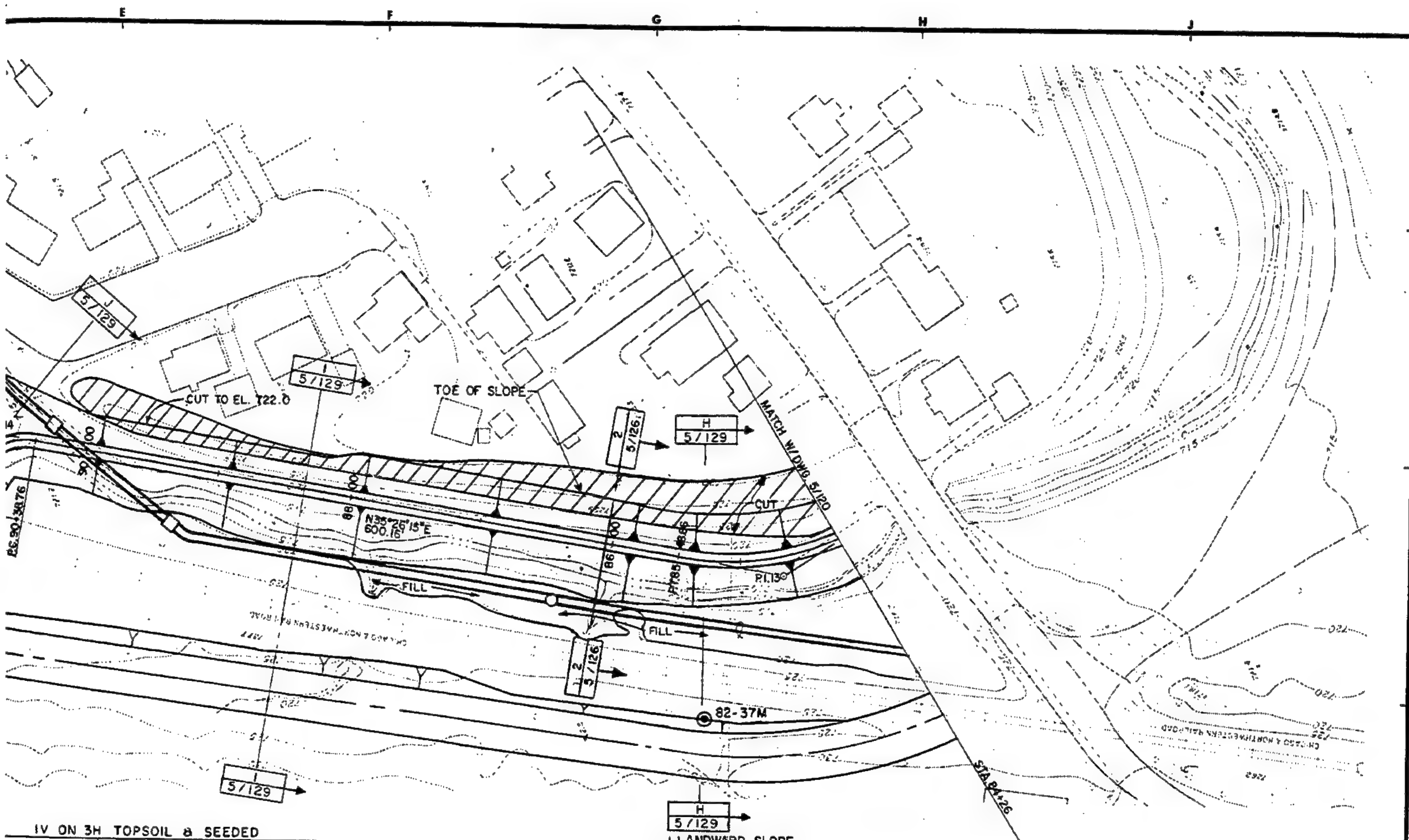
DESIGNED BY: D.R.G.
DRAWN BY: L.K.K.
CHECKED BY: M.A.M. C.P.S.
SUBMITTED BY: [signature]

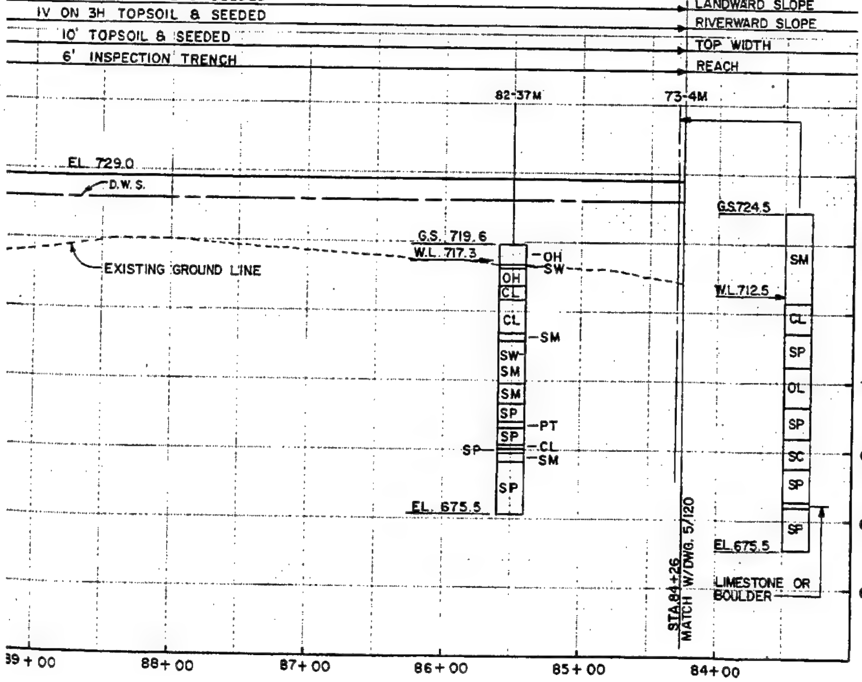
FLOOD CONTROL — FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
LEVEE IMPROVEMENTS
PLAN & PROFILE
STA. 70+00 TO STA. 84+26

APPROVED: [signature]
DATE: OCT. 1984
SCALE: AS SHOWN
DRAWING NUMBER M34-CH-R-5/120
SHEET 1 OF 2


CUT TO EL. 722.0
5/129
PT90+90.74
N24°07'30"W
82.10'
91+72.74
P.I.14
RC.90+38.76
80-28M
IV ON 3H TOPSOIL & SEEDED
IV ON 3H TOPSOIL & SEEDED
10' TOPSOIL & SEEDED
6' INSPECTION TRENCH
EL. 729.0
D.W.S.
EXISTING GROUND LINE
93+00
92+00
91+00
90+00
89+00
88+00

1





NOTES:

1. INSPECTION TRENCH REQUIRED THIS REACH.
2. SEE DWG NO. 5/116 FOR CHANNEL DETAILS.
3. SEE DWG NO. 5/123 FOR OUTLET "A" DETAILS.

P.I.-13	P.I.-14
R=212.2066'	R=50.00'
Δ=42°06'15	Δ=59°33'45"
T=81.644	T=28.614'
CL=155.680'	CL=51.978'

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: P.D.M. & D.R.G.
DRAWN BY: L.K.K.
CHECKED BY: C.P.S., M.A. M.
SUBMITTED BY:

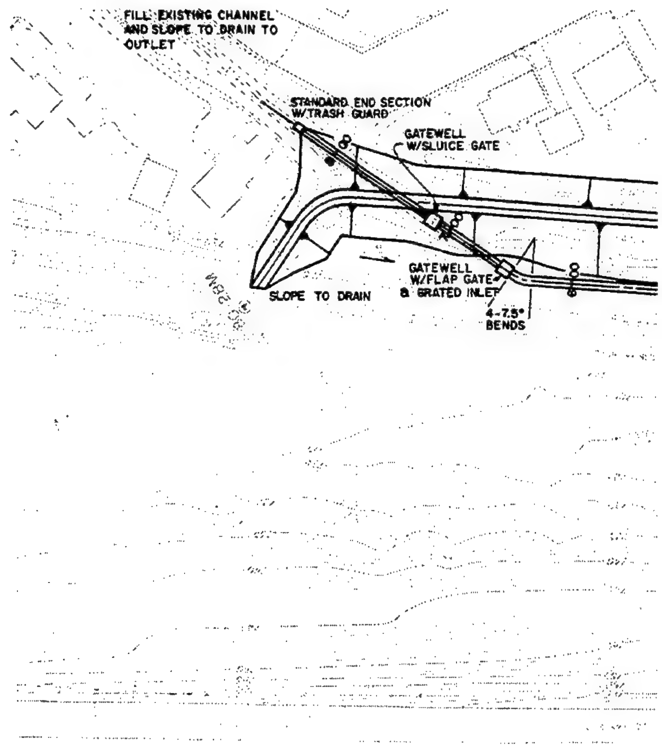
FLOOD CONTROL FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
LEVEE IMPROVEMENTS
PLAN & PROFILE
STA. 83+82 TO STA. 91+65

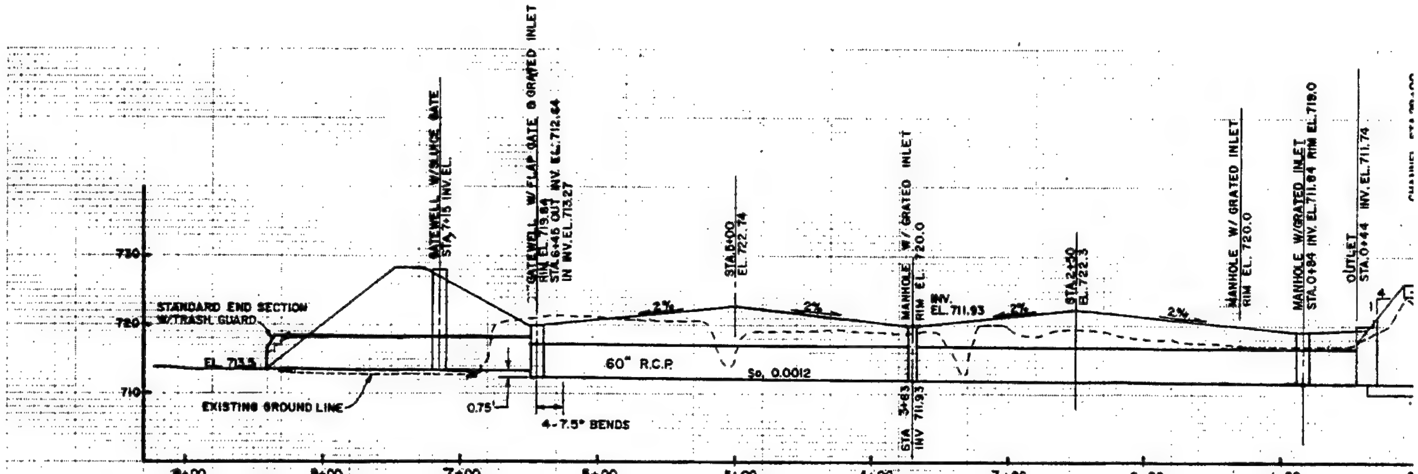
APPROVED: DATE: OCT. 1984

SCALE: AS SHOWN
DRAWING NUMBER M34-CH-R-5/121
SHEET 2 OF 2

PLATE 9

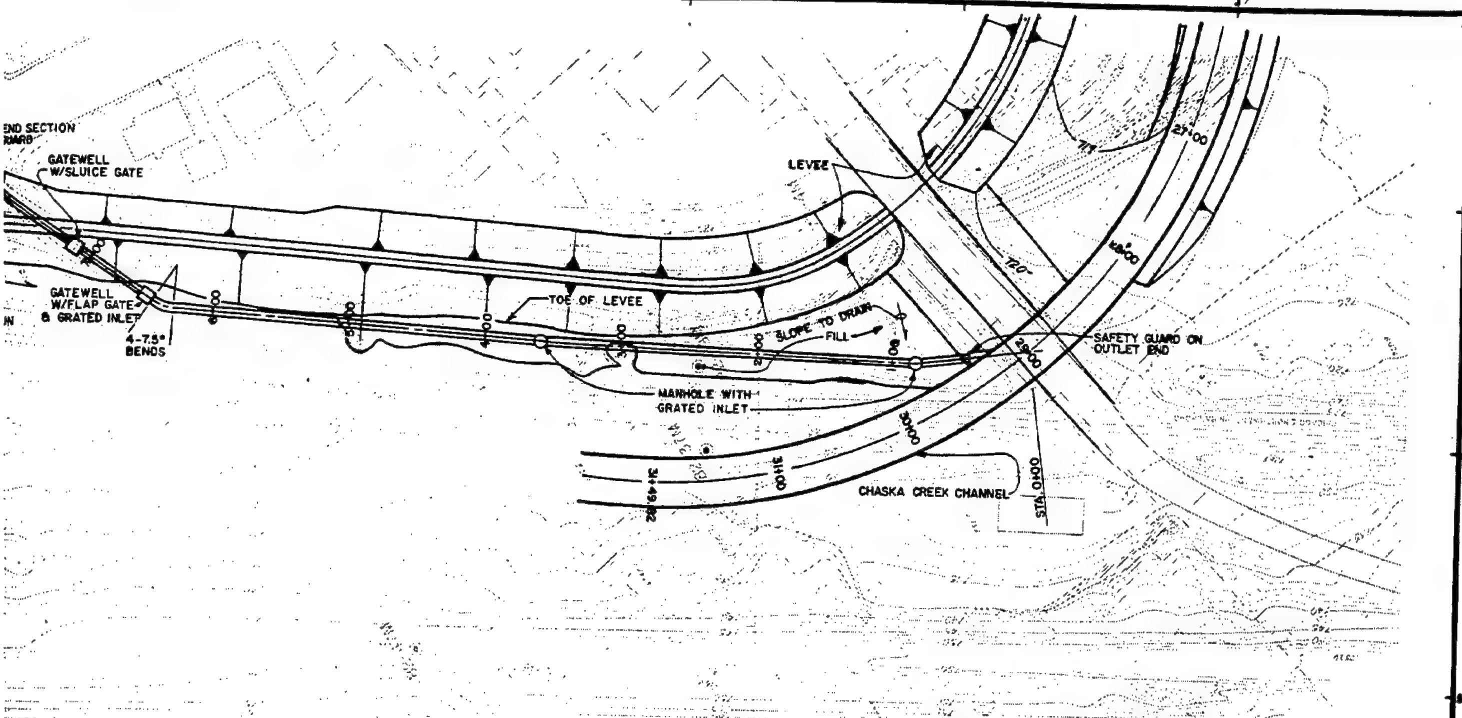
(2)



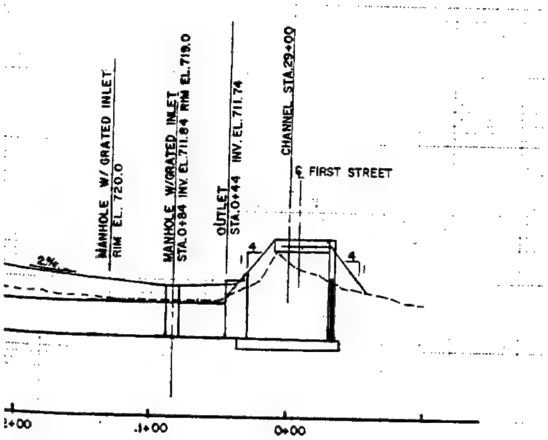


CENTERLINE PROFILE

(1)



PLAN



NOTES:

1. SEE DWG NO. 5/116 FOR CHANNEL DETAILS.
2. SEE DWG NO. 5/121 FOR LEVEE DETAILS.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

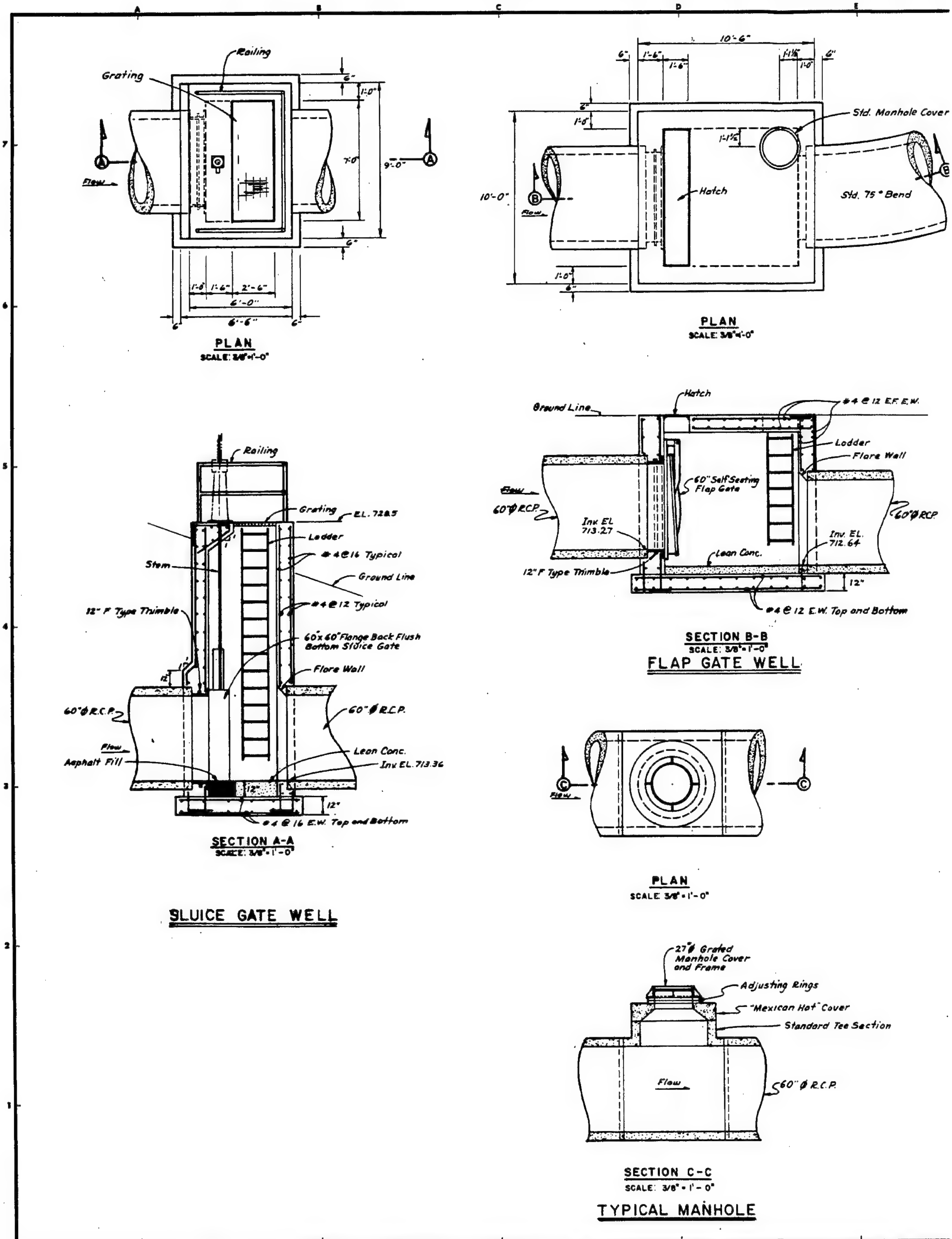
DESIGNED BY: MDL
DRAWN BY: LKK
CHECKED BY: M.A.M. MDL
SUBMITTED BY:

FLOOD CONTROL FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
OUTLET A
PLAN & PROFILE

APPROVED:
DATE: OCT. 1984
SCALE: AS SHOWN
DRAWING NUMBER M34-CH-R-5/123
SHEET OF

PLATE 10

2



Railing
Grating
Flow
6"
1'-0"
7'-0"
9'-0"
1'-6" 1'-6" 2'-6"
6'-0"
6'-6"
PLAN
SCALE: 3/8"=1'-0"
Stem
12" F Type Thimble
Grating
EL. 728.5
Ladder
#4@16 Typical
Ground Line
#4@12 Typical
60"x60" Flange Back Flush Bottom Sluice Gate
Flare Wall
60"∅R.C.P.
Asphalt Fill
Lean Conc.
Inv EL. 713.36
12"
#4 @ 16 E.W. Top and Bottom
SECTION A-A
SCALE: 3/8"=1'-0"
SLUICE GATE WELL
10'-6"
1'-6"
1'-1½"
1'-0"
10'-0"
Std. Manhole Cover
Hatch
Std. 75° Bend
PLAN
SCALE: 3/8"=1'-0"
Hatch
Ground Line
#4 @ 12 E.F. E.W.
Ladder
Flare Wall
60" Self Seating Flap Gate
60"∅RCP
Inv. EL 713.27
Inv. EL. 712.64
Lean Conc.
12" F Type Thimble
#4 @ 12 E.W. Top and Bottom
SECTION B-B
SCALE: 3/8"=1'-0"
FLAP GATE WELL
PLAN
SCALE: 3/8"=1'-0"
27"∅ Grated Manhole Cover and Frame
Adjusting Rings
"Mexican Hat" Cover
Standard Tee Section
Flow
60"∅ R.C.P.
SECTION C-C
SCALE: 3/8"=1'-0"
TYPICAL MANHOLE

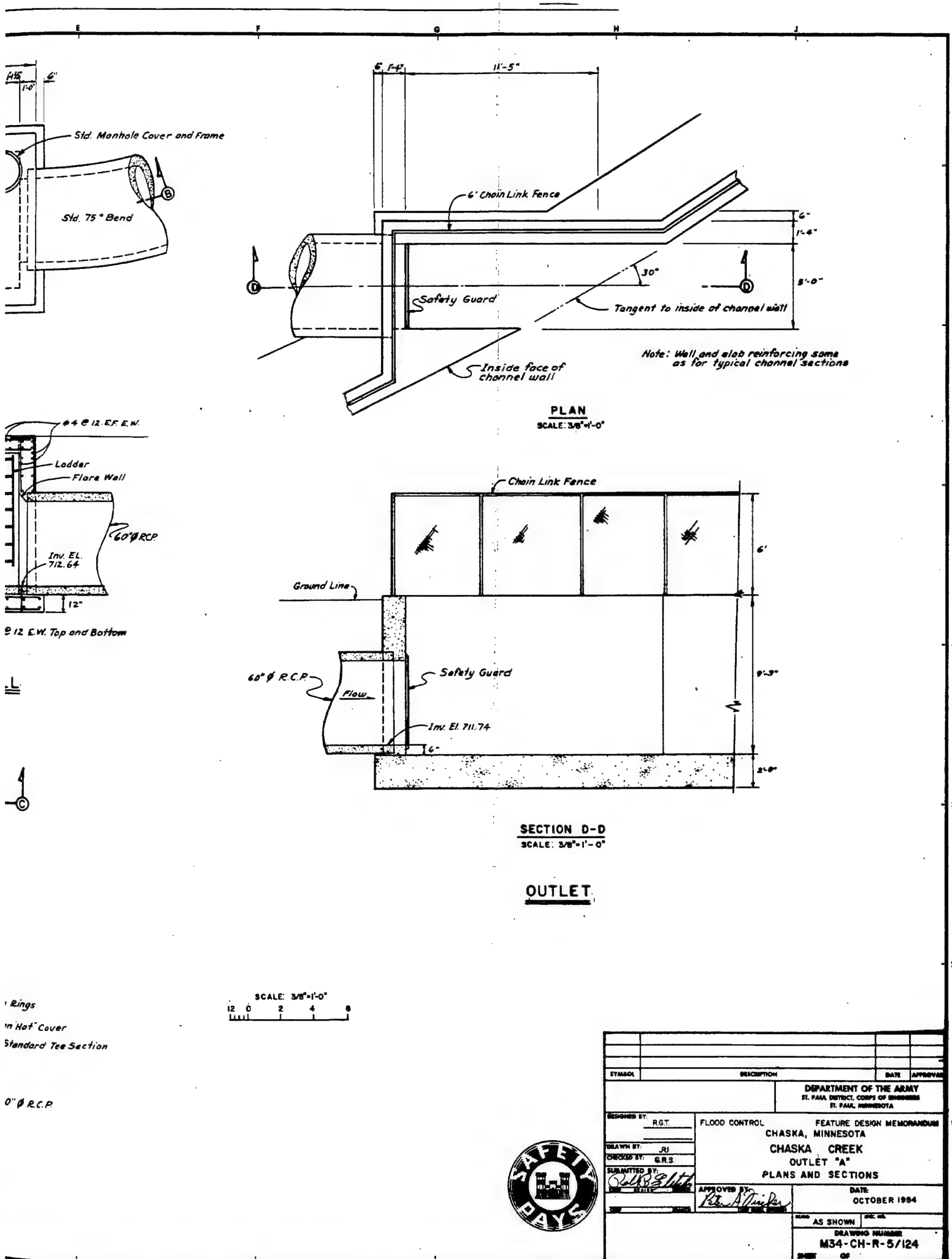
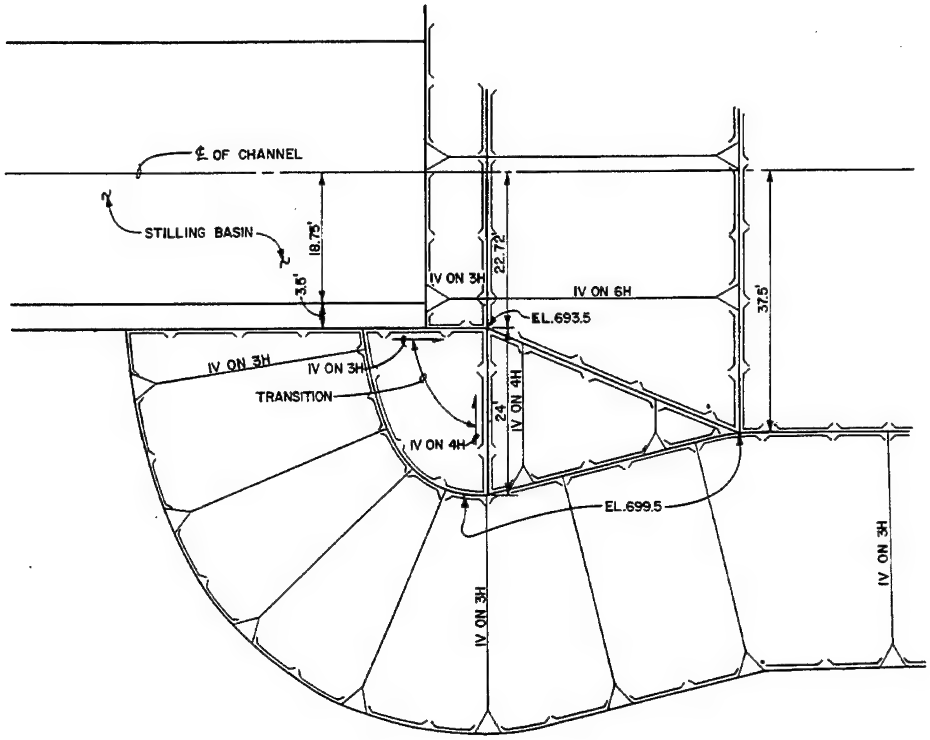

Std. Manhole Cover and Frame
Std. 75° Bend
6' Chain Link Fence
11'-5"
30°
Safety Guard
Tangent to inside of channel wall
Inside face of channel wall
Note: Wall and slab reinforcing same as for typical channel sections
PLAN
SCALE: 3/8"=1'-0"
#4 @ 12 E.F. E.W.
Ladder
Flare Wall
60"Ø RCP
Inv. EL. 712.64
@ 12 E.W. Top and Bottom
Chain Link Fence
Ground Line
6'
9'-3"
2'-6"
60"Ø R.C.P.
Flow
Safety Guard
Inv. El. 711.74
SECTION D-D
SCALE: 3/8"=1'-0"
OUTLET
SCALE: 3/8"=1'-0"
Rings
Hat" Cover
Standard Tee Section
0"Ø R.C.P.
SAFETY DAYS
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
DESIGNED BY: R.G.T.
DRAWN BY: RJ
CHECKED BY: G.R.S.
FLOOD CONTROL
FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
CHASKA CREEK
OUTLET "A"
PLANS AND SECTIONS
DATE: OCTOBER 1984
AS SHOWN
DRAWING NUMBER
M34-CH-R-5/124

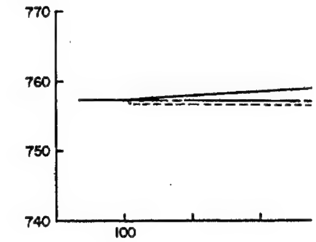
PLATE 11

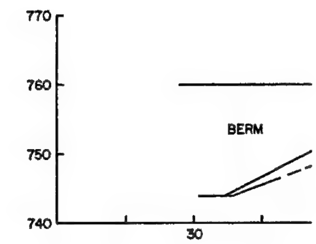
2

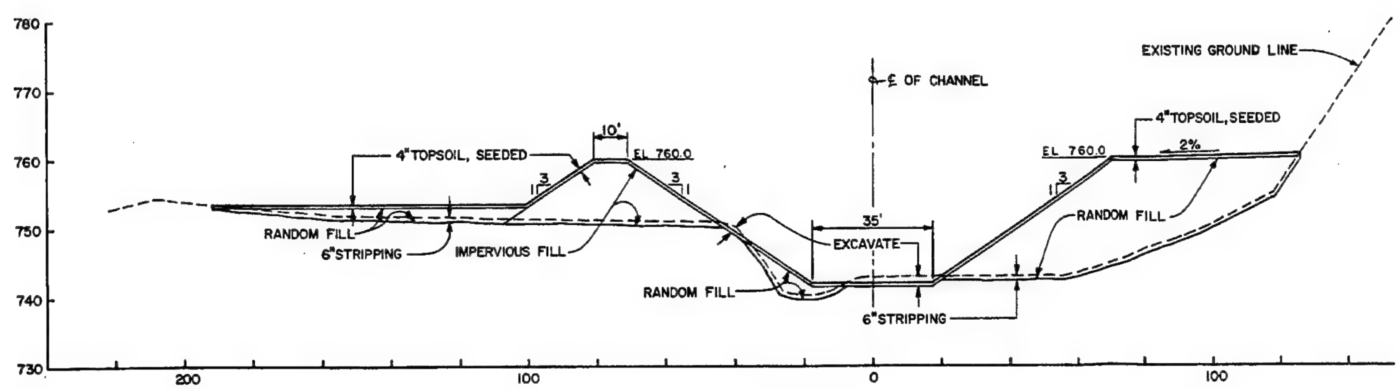


PREFORMED SCOUR HOLE

DETAIL 3 / 5/115

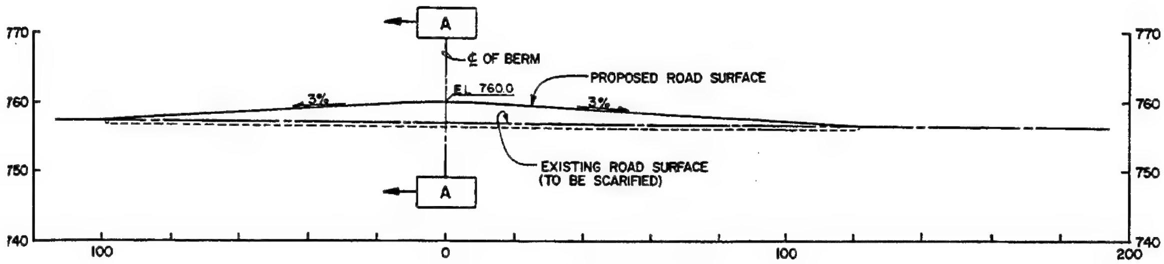




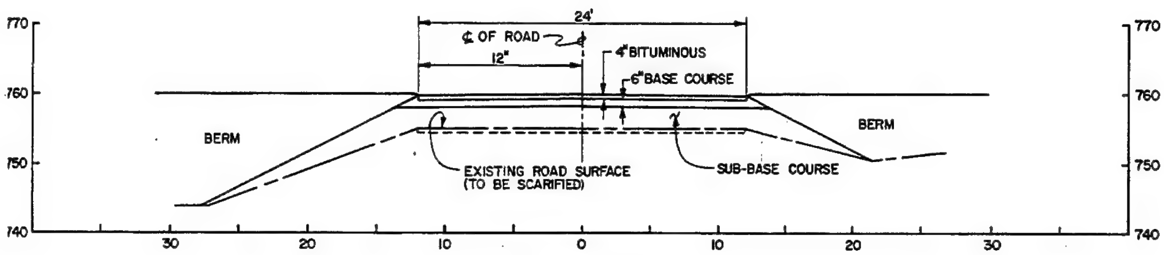


SECTION Q2 / 5/118

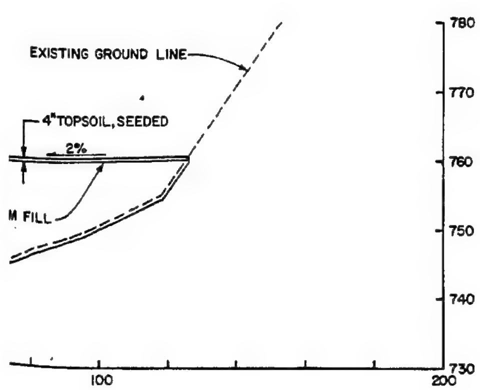
1



DETAIL V 5/119



SECTION A - A



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

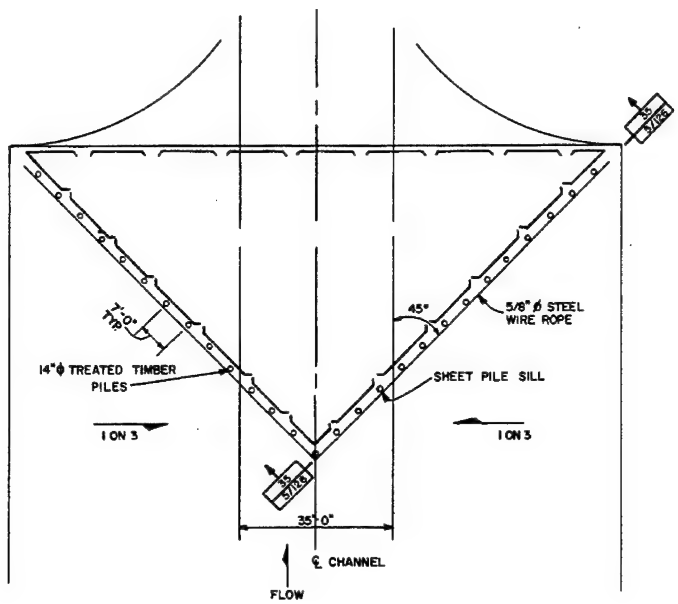
DESIGNED BY: LAR
DRAWN BY: PPC
CHECKED BY: CPS MAM
SUBMITTED BY:
CHIEF DESIGN BRANCH
CHIEF ED-DS BRANCH
APPROVED BY:
CHIEF ENGR. DIVISION

FLOOD CONTROL FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
CSAH 10 PROFILE
SCOUR HOLE DETAILS & SECTIONS

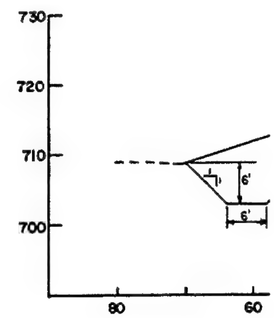
DATE: OCT. 1984
SCALE: AS SHOWN
SPEC. NO.
DRAWING NUMBER: M34-CH-R-5/125
SHEET OF

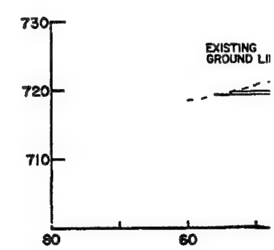
PLATE 12

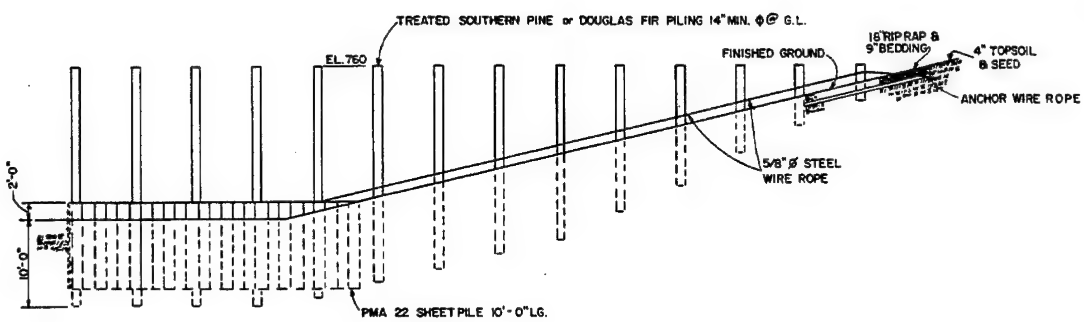
2



PLAN
SCALE: 1/16" = 1'-0"



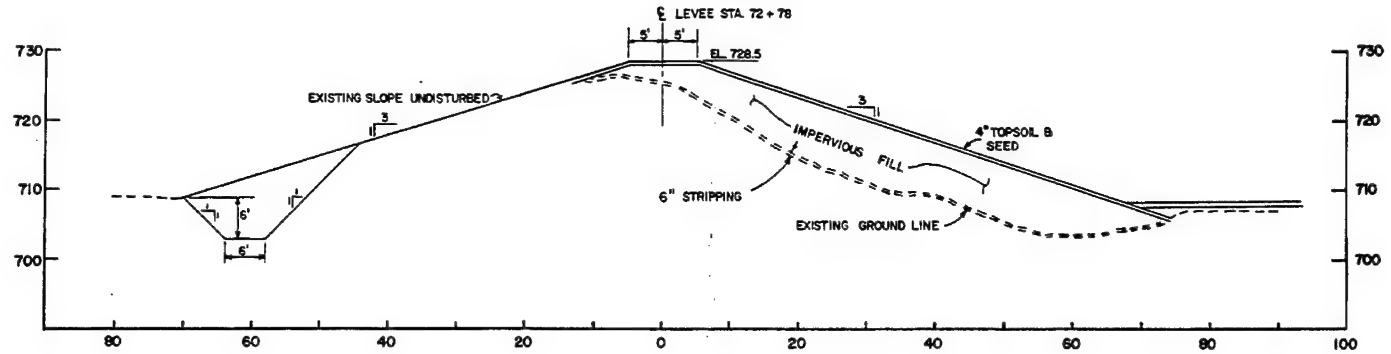




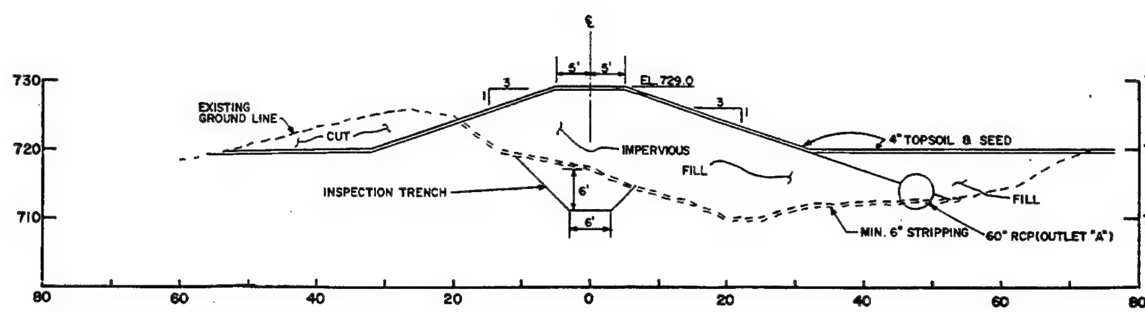
SECTION $\frac{35}{5/126}$
SCALE: 1/8" = 1'-0"

TRASH GUARD

(1)



SECTION 1 / 5/120



OIL

IRE ROPE

SECTION 2 / 5/121

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: RGT
DRAWN BY: G.A.O
CHECKED BY: LAR
SUBMITTED BY:
CHIEF DESIGN BRANCH
CHIEF BRANCH

FLOOD CONTROL — FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA

LEVEE SECTIONS AND TRASH GUARD

APPROVED:
CHIEF ENGR. DIVISION

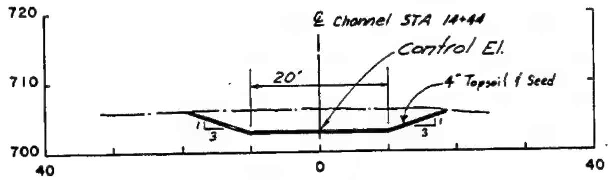
DATE: OCT. 1984

SCALE: AS SHOWN

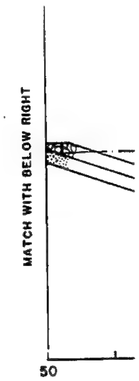
DRAWING NUMBER
M34-CH-R-5/126
SHEET OF

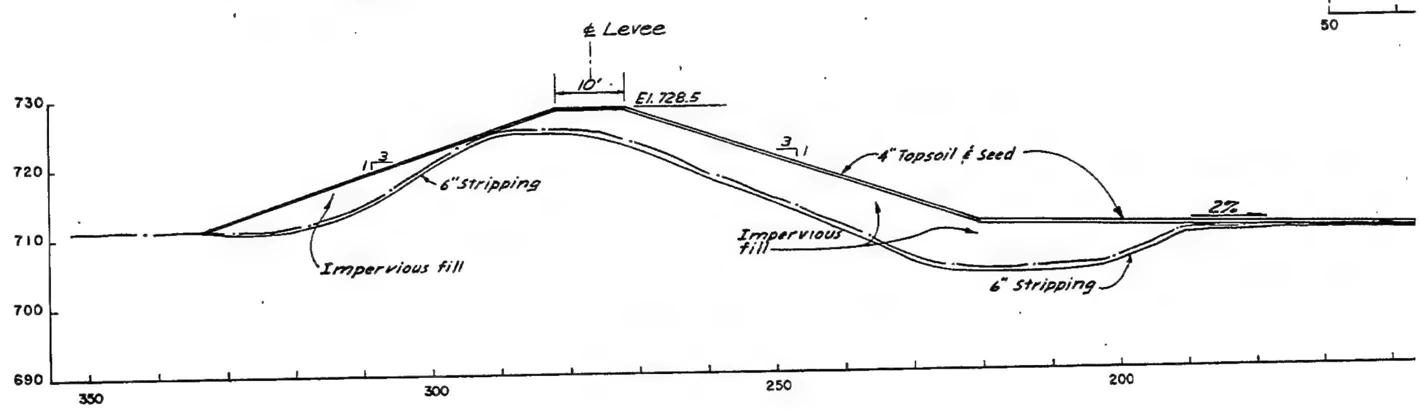
PLATE 13

(2)

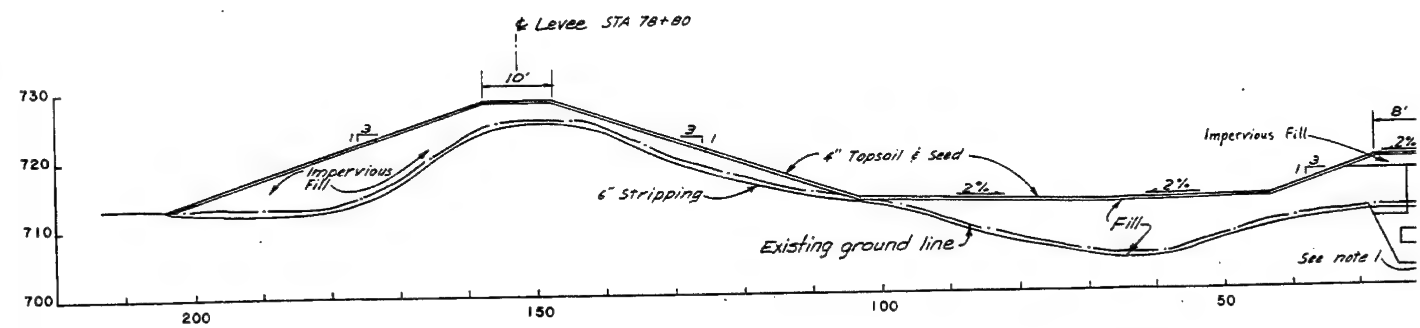


SECTION A/5/115

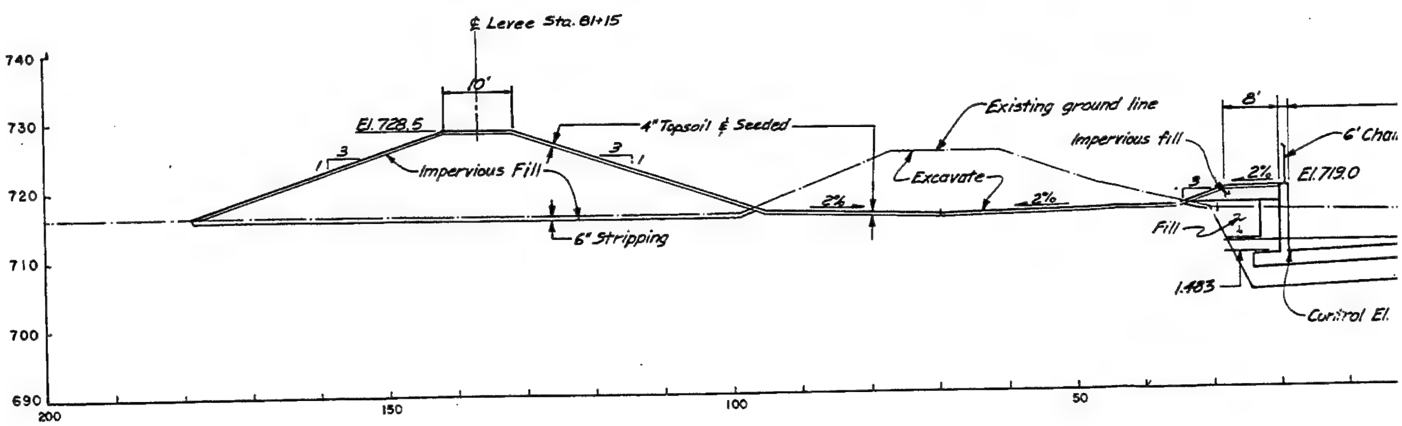




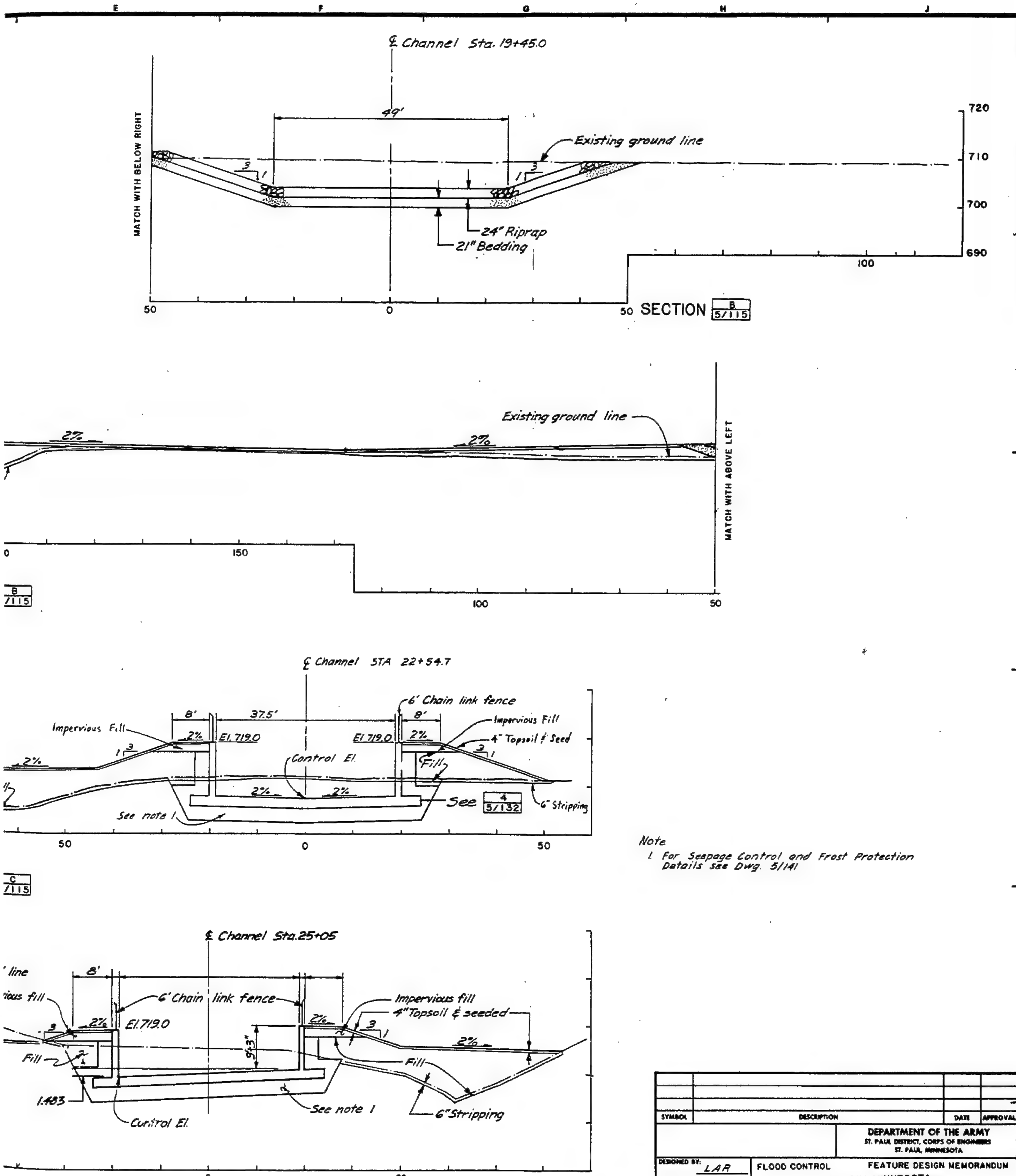
SECTION B/5/115



SECTION C/5/115



SECTION D/5/115



Note
1. For Seepage Control and Frost Protection Details see Dwg. 5/141

SYMBOL	DESCRIPTION	DATE	APPROVAL

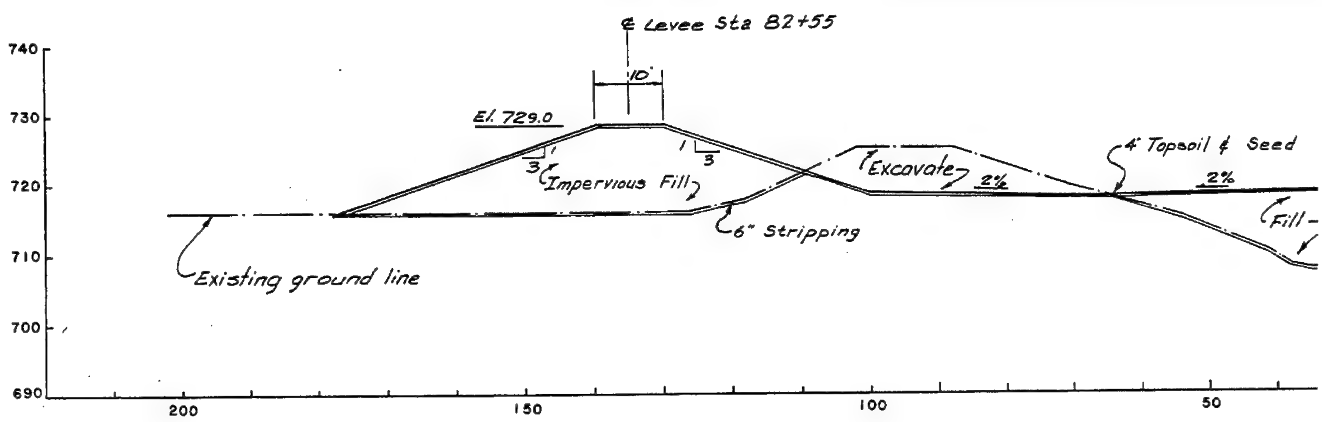
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: LAR
DRAWN BY:
CHECKED BY: CPS MAM
SUBMITTED BY:
APPROVED BY:

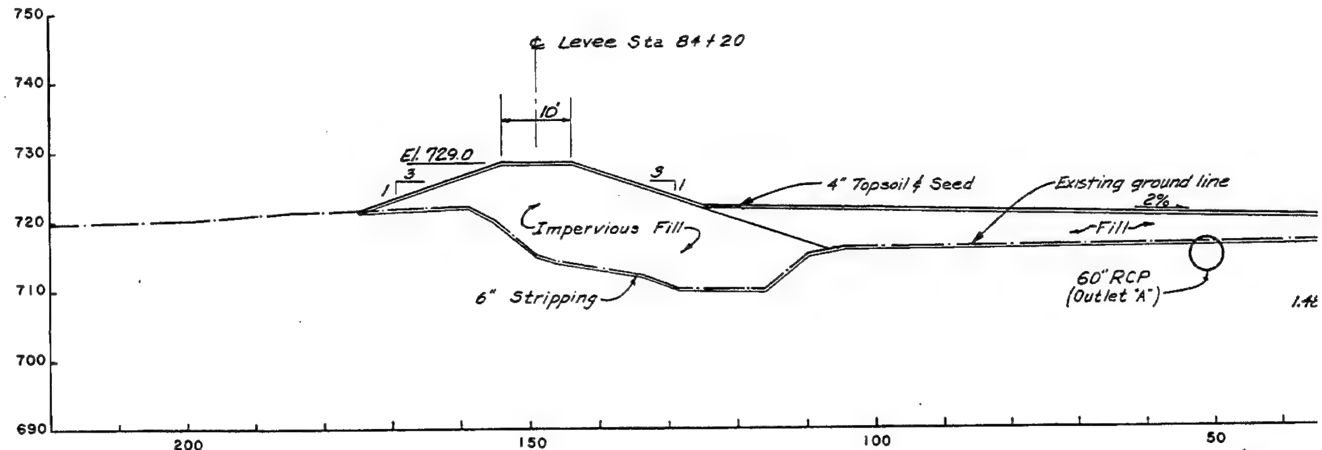
FLOOD CONTROL FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
CHASKA CREEK
SECTIONS

DATE: OCTOBER 1984
SCALE: AS SHOWN
DRAWING NUMBER: M34-CH-R-5/127

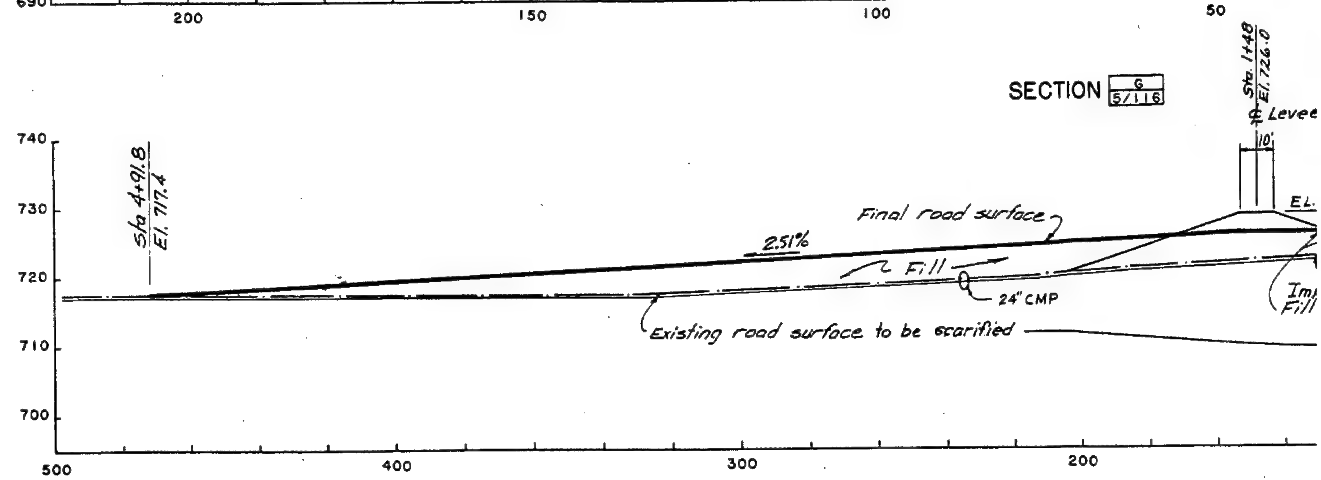
PLATE 14



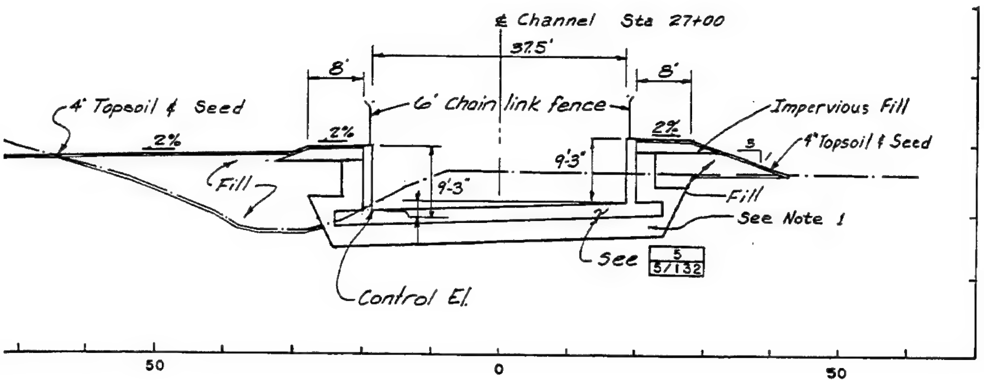
SECTION $\frac{E}{5/115}$



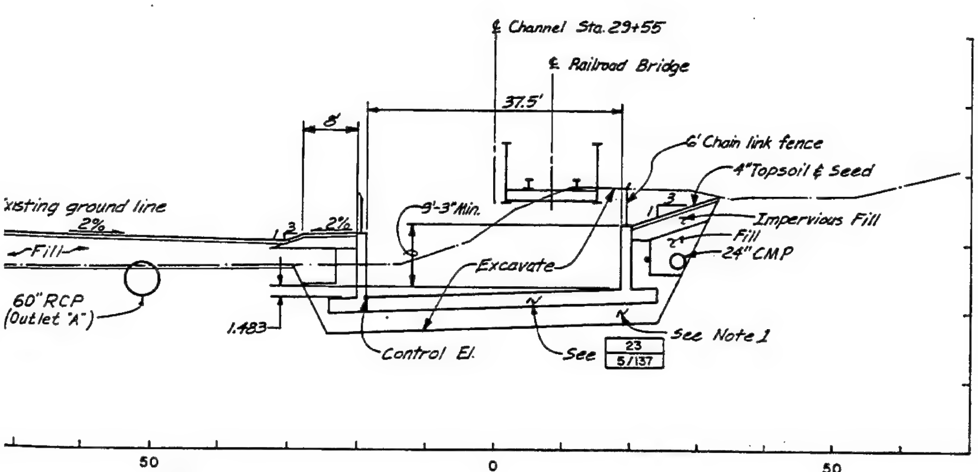
SECTION $\frac{G}{5/116}$



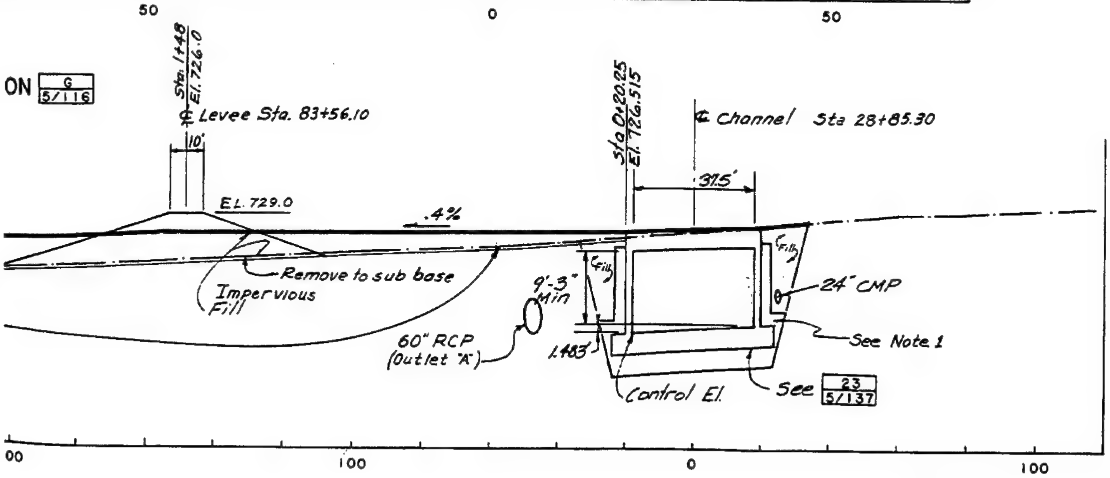
SECTION $\frac{F}{5/116}$



ION E/5/115



ON G/5/116



ON F/5/116

Note:
1. For Seepage Control and Frost Protection Details See Dwg 5/141.
2. For Outlet "A" Plan ¢ Profile See Dwg 5/123.

SYMBOL	DESCRIPTION	DATE	APPROVAL

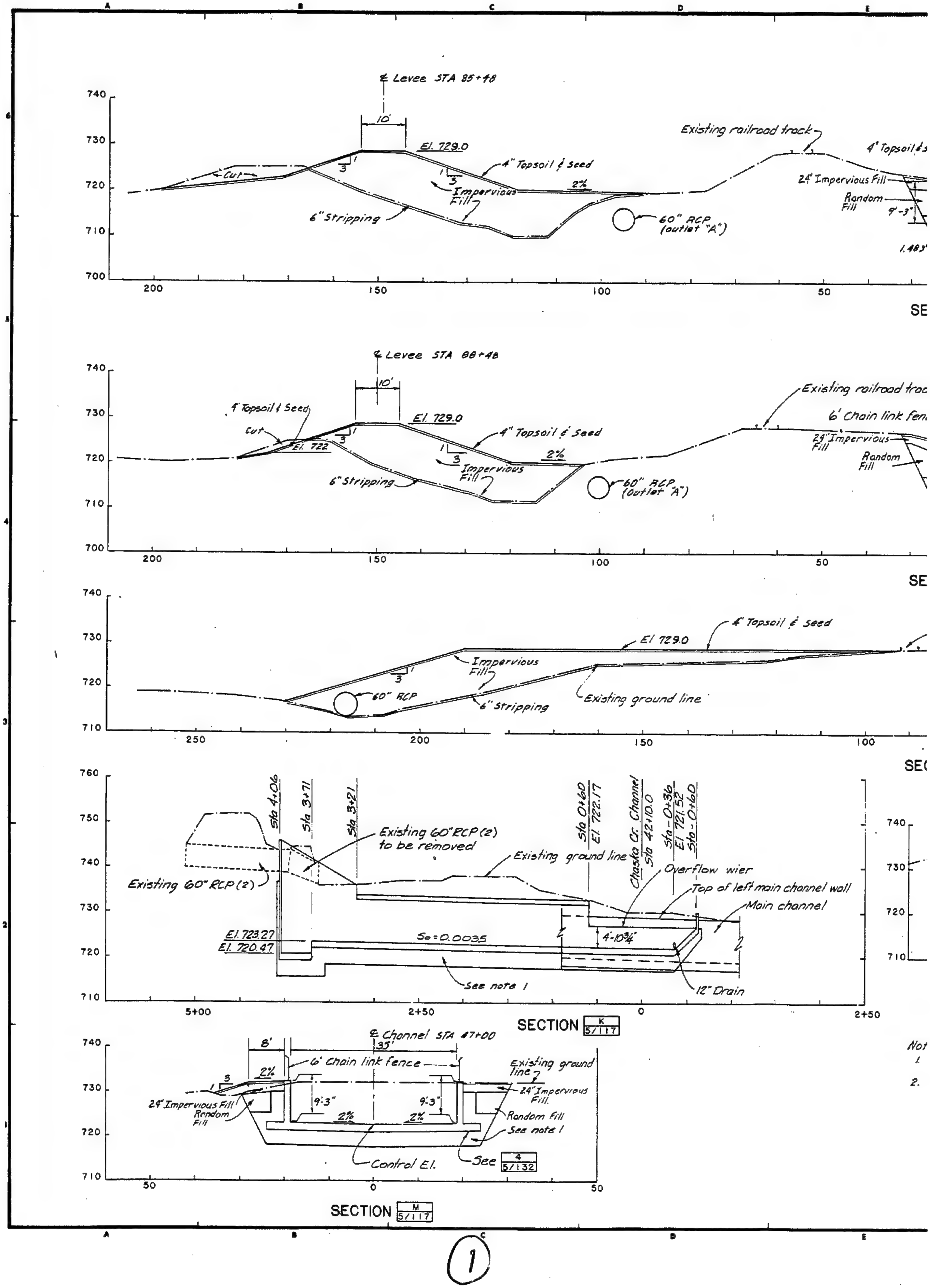
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: LAR
DRAWN BY:
CHECKED BY: CPS, MAM
SUBMITTED BY:

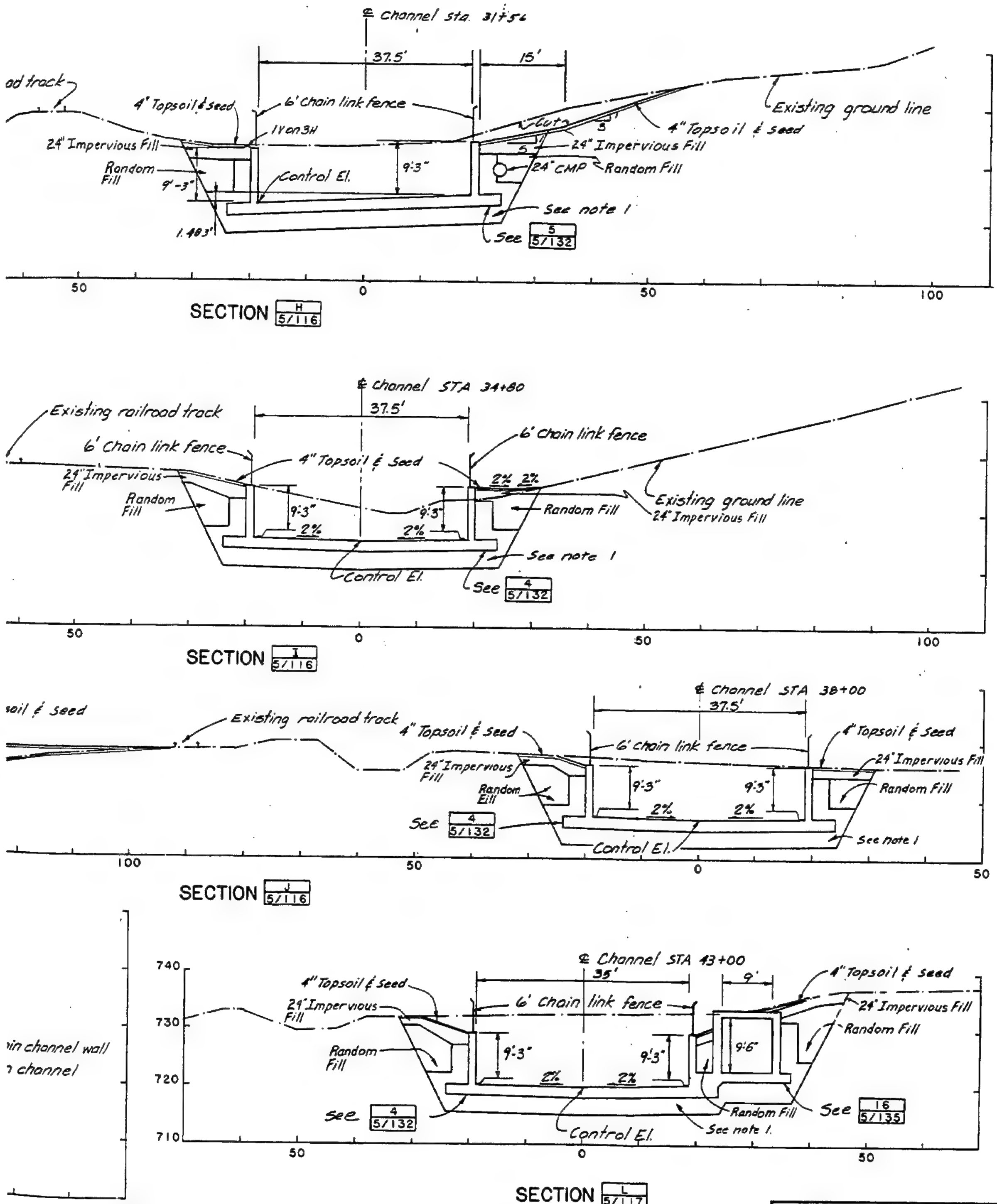
FLOOD CONTROL — FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
CHASKA CREEK
SECTIONS

APPROVED BY:
DATE: OCT. 1984
SCALE: AS SHOWN
DRAWING NUMBER: M34-CH-R-5/128
SHEET OF

PLATE 15



℄ Levee STA 85+48
10'
El. 729.0
Existing railroad track
4" Topsoil & Seed
Cut
Impervious Fill
2%
6" Stripping
60" RCP (outlet "A")
24" Impervious Fill
Random Fill
9'-3"
℄ Levee STA 88+48
4" Topsoil & Seed
El. 722
6' Chain link fence
El 729.0
4" Topsoil & seed
60" RCP
Existing ground line
Sta 4+06
Sta 3+71
Sta 3+21
Existing 60" RCP (2) to be removed
Existing ground line
Sta 0+60
El. 722.17
Chaska Cr. Channel Sta 42+10.0
Sta -0+36
El 721.52
Sta -0+60
Overflow wier
Top of left main channel wall
Main channel
Existing 60" RCP (2)
El. 723.27
El. 720.47
So=0.0035
4'-10¾"
See note 1
12" Drain
SECTION K/5/117
℄ Channel STA 47+00
8'
35'
6' Chain link fence
Existing ground line
24" Impervious Fill
Random Fill
9'-3"
2%
See note 1
Control El.
See 4/5/132
SECTION M/5/117



Notes:

1. *For seepage control and frost protection details see dwg 5/141*
2. *For outlet "A" Plan and Profile see dwg 5/123*

SYMBOL	DESCRIPTION	DATE	APPROVAL

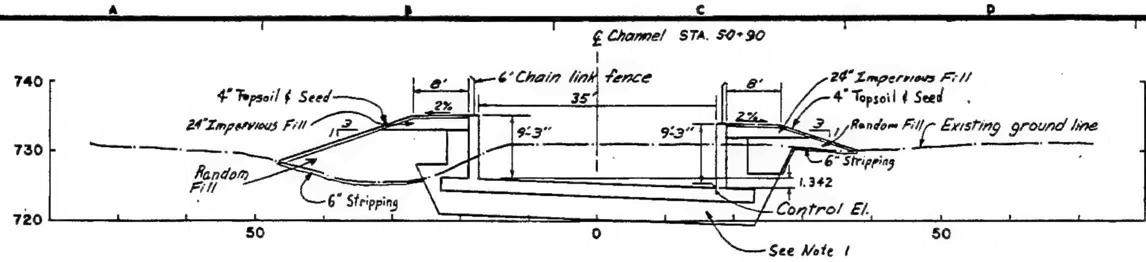
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: LAR
DRAWN BY: WP
CHECKED BY: CPS MAM
SUBMITTED BY:
APPROVED BY:

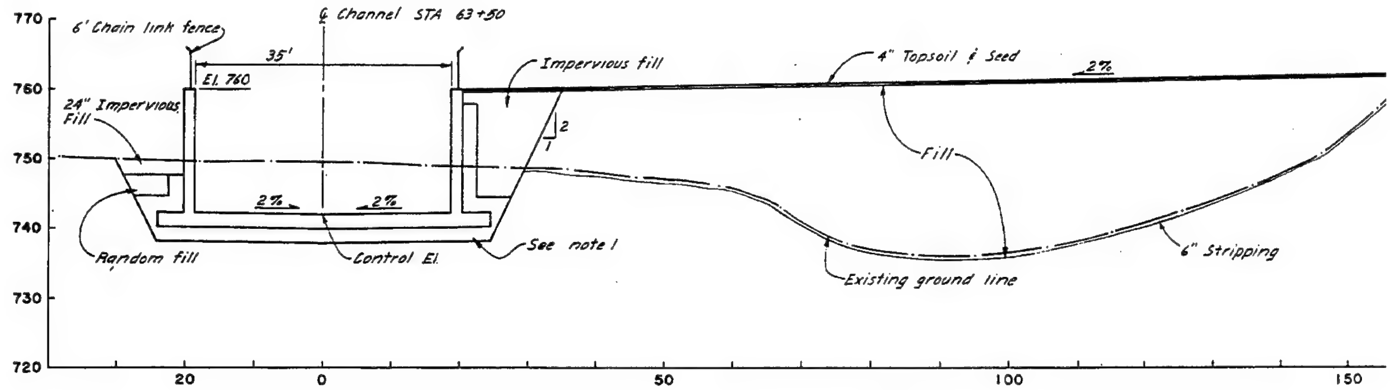
FLOOD CONTROL — FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
CHASKA CREEK
SECTIONS

DATE: OCT. 1984
SCALE: AS SHOWN
DRAWING NUMBER: M34-CH-R-5/129

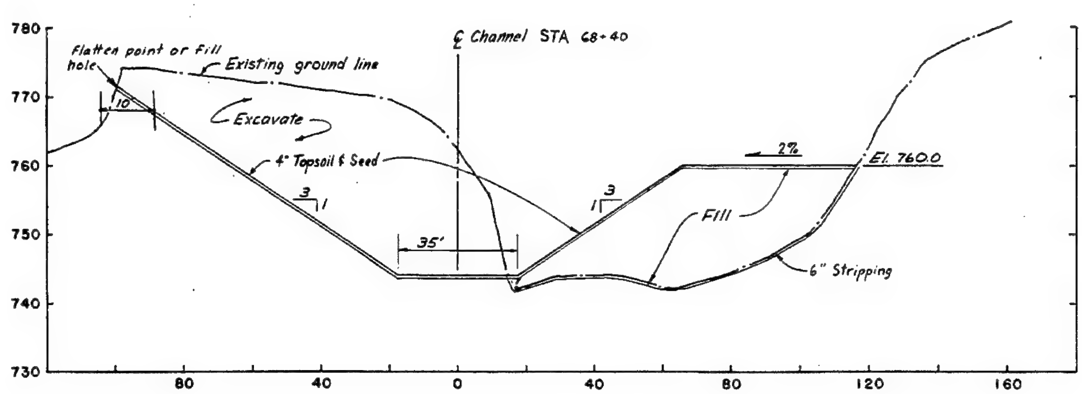
PLATE 16



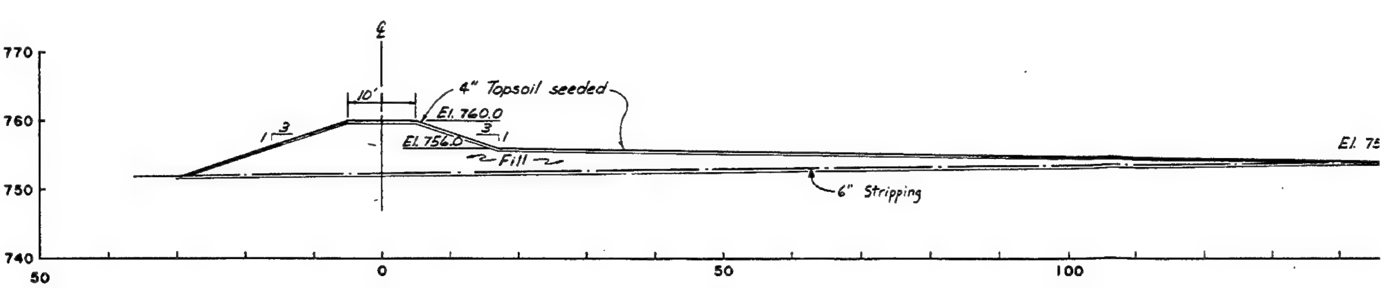
SECTION $\frac{N}{5/117}$



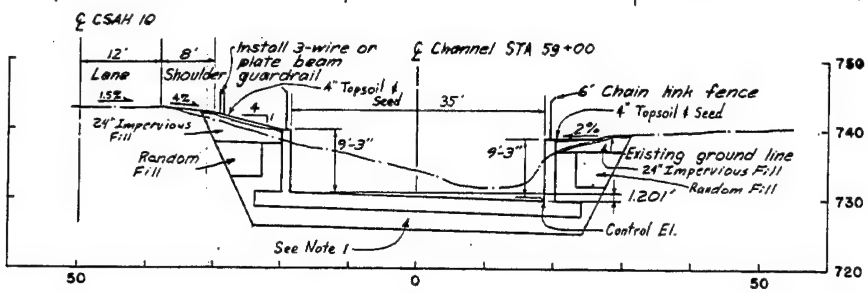
SECTION $\frac{Q}{5/118}$



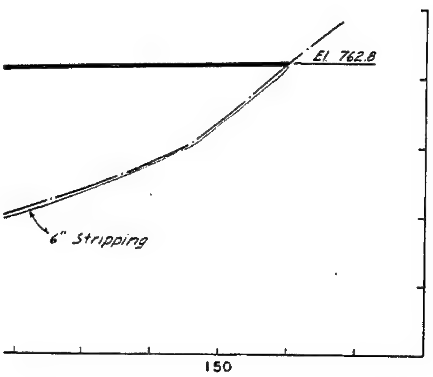
SECTION $\frac{S}{5/119}$

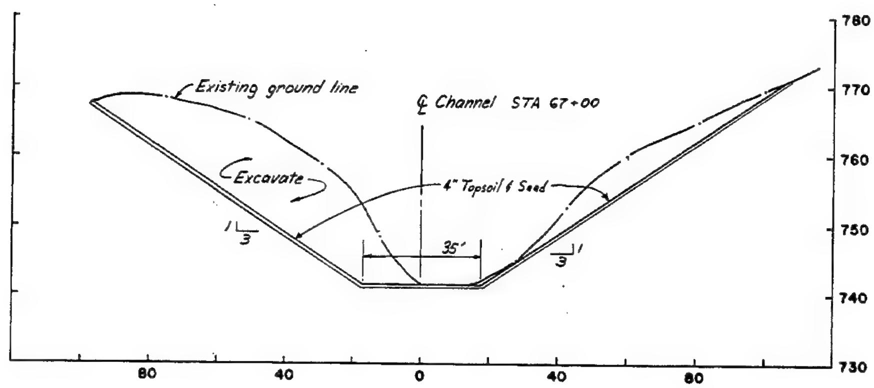


SECTION $\frac{U}{5/119}$

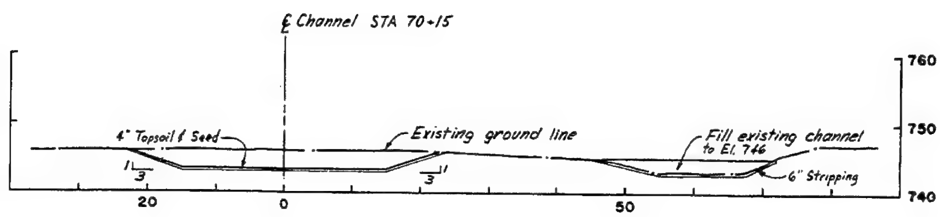


SECTION $\frac{P}{5/118}$





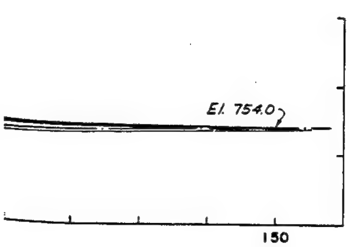
SECTION $\frac{R}{5/118}$



SECTION $\frac{T}{5/119}$

NOTES:

1. FOR SEEPAGE AND FROST PROTECTION DETAILS SEE DWG 5/141.



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

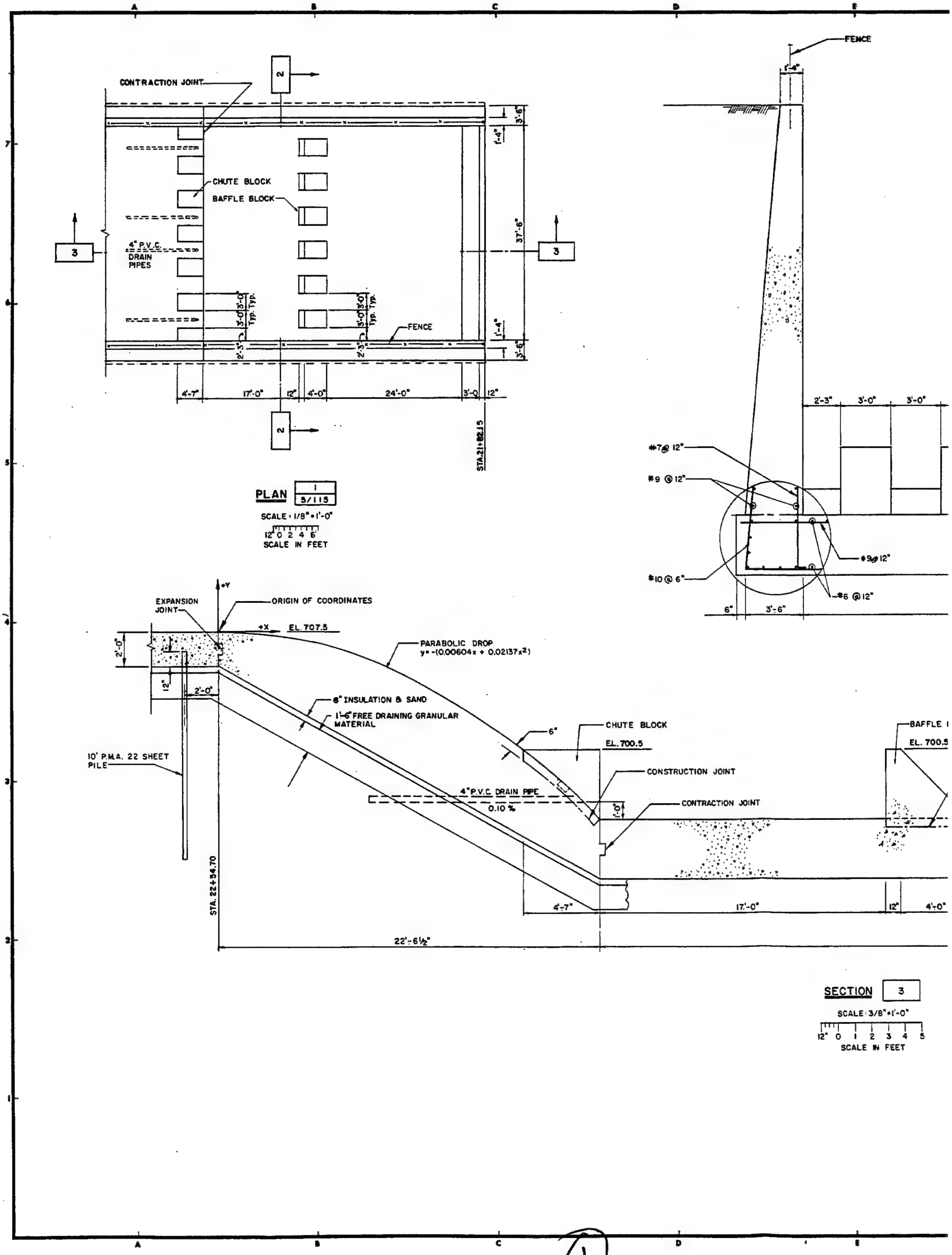
DESIGNED BY: L.A.R.
DRAWN BY: W P
CHECKED BY: C P S MAM
SUBMITTED BY:

FLOOD CONTROL FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
CHASKA CREEK
SECTIONS

APPROVED BY:
DATE: OCT. 1984
SCALE: AS SHOWN
DRAWING NUMBER: M34-CH-R-5/130
SHEET OF

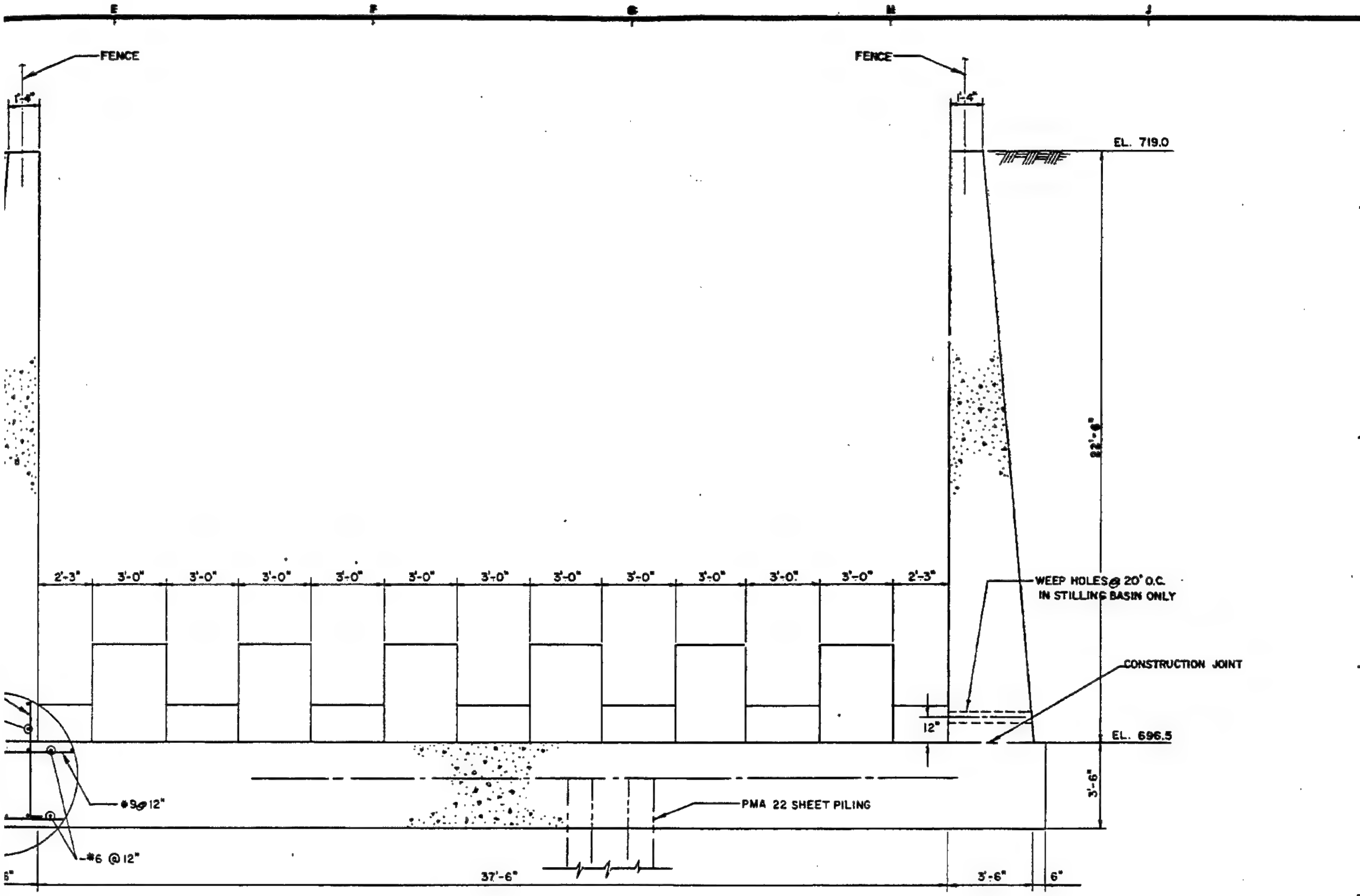
PLATE 17

2



CONTRACTION JOINT
CHUTE BLOCK
BAFFLE BLOCK
4" P.V.C. DRAIN PIPES
FENCE
37'-6"
3'-6"
1'-4"
3'-0" 3'-0" Typ. Typ.
2'-3"
4'-7"
17'-0"
12"
4'-0"
24'-0"
3'-0
STA.21+82.15
PLAN 1 5/115
SCALE : 1/8" = 1'-0"
12" 0 2 4 6
SCALE IN FEET
EXPANSION JOINT
ORIGIN OF COORDINATES
+Y
+X
EL. 707.5
2'-0"
12"
PARABOLIC DROP
y = -(0.00604x + 0.02137x²)
6" INSULATION & SAND
1'-6" FREE DRAINING GRANULAR MATERIAL
6"
CHUTE BLOCK
EL. 700.5
CONSTRUCTION JOINT
4" P.V.C. DRAIN PIPE
0.10 %
1'-0"
CONTRACTION JOINT
10' P.M.A. 22 SHEET PILE
STA. 22+54.70
4'-7"
17'-0"
12"
4'-0"
22'-6½"
BAFFLE
EL. 700.5
#7 @ 12"
#9 @ 12"
#9 @ 12"
#10 @ 6"
#6 @ 12"
6"
3'-6"
2'-3"
3'-0"
3'-0"
1'-4"
SECTION 3
SCALE : 3/8" = 1'-0"
12" 0 1 2 3 4 5
SCALE IN FEET

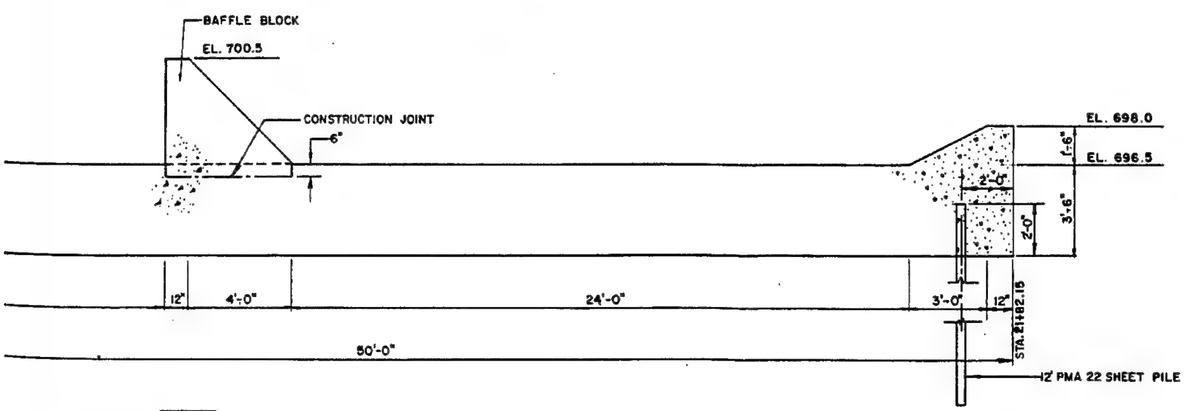
1



SECTION 2

SCALE: 3/8"=1'-0"

12" 0 1 2 3 4 5
SCALE IN FEET



SECTION 3

SCALE: 3/8"=1'-0"

12" 0 1 2 3 4 5
SCALE IN FEET

REFERENCES

1. FOR SEEPAGE CONTROL AND FROST PROTECTION, SEE DRAWING 5/141
2. FENCE DETAIL SEE DRAWING 5/141
3. FOR WEEP HOLE AND FLAP VALVE DETAIL SEE DRAWING 5/141
4. FOR JOINT DETAIL SEE DRAWING 5/141

SYMBOL	DESCRIPTION	DATE	APPROVAL

BONESTROO, ROSENE, ANDERLIK & ASSOC., INC.
CONSULTING ENGINEERS
St. Paul, Minnesota

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

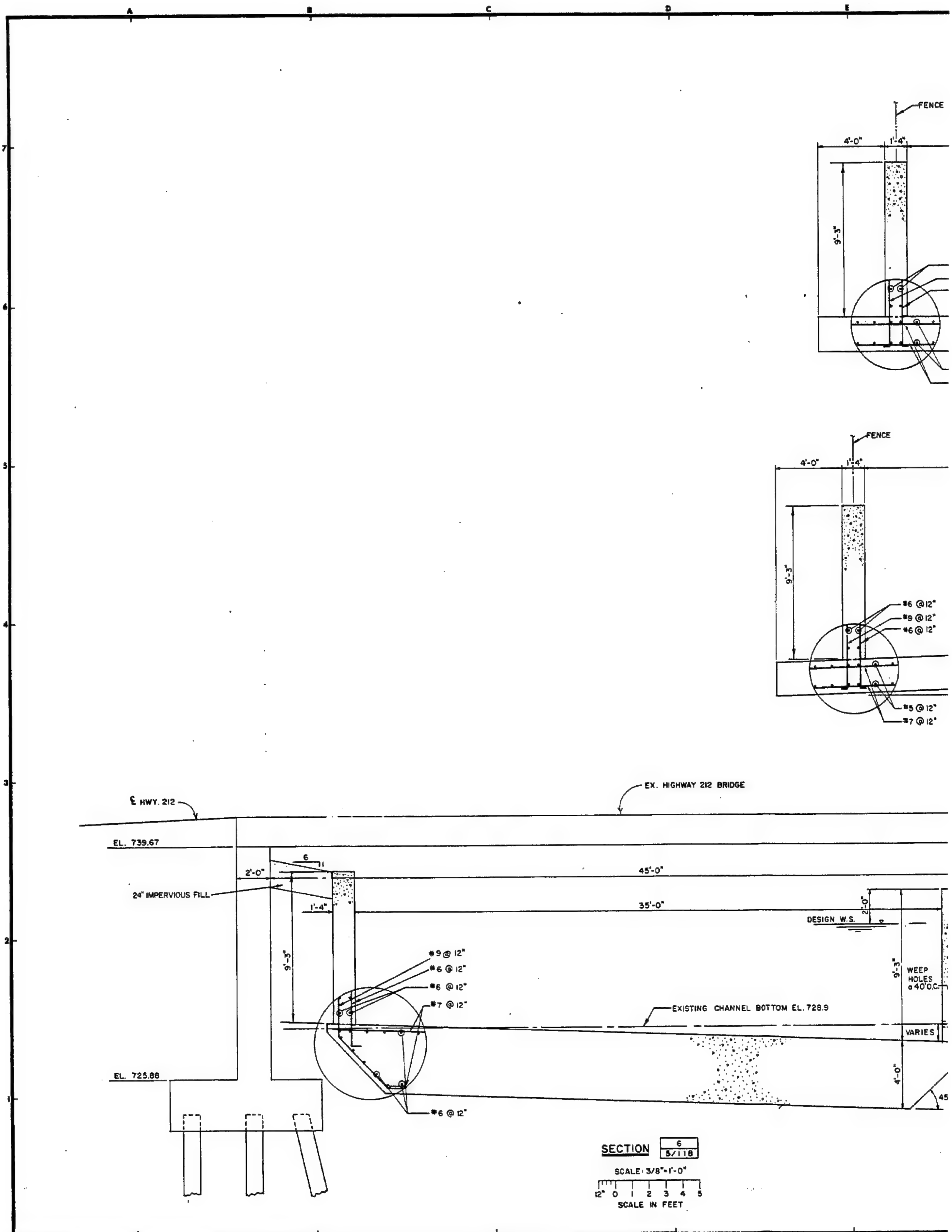
DESIGNED BY: KAB
DRAWN BY: KRL
CHECKED BY: MTR
SUBMITTED BY:

FLOOD CONTROL FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
CHASKA CREEK
STILLING BASIN

APPROVED:
DATE: OCTOBER 1984
SCALE: AS SHOWN
DRAWING NUMBER M34-CH-R-5/131
SHEET OF

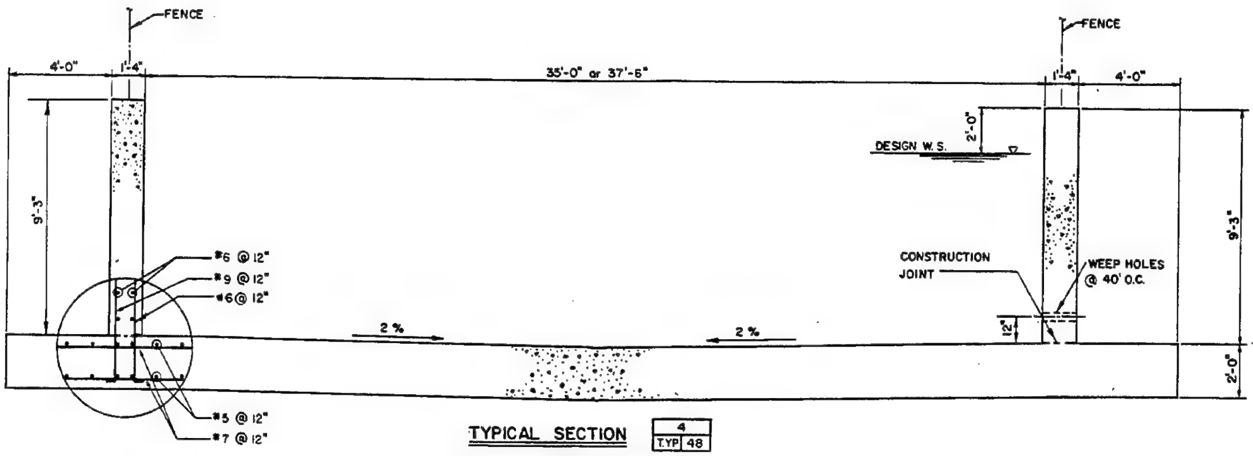
PLATE 18

(2)



A
B
C
D
E
7
6
5
4
3
2
1
FENCE
4'-0"
1'-4"
9'-3"
FENCE
4'-0"
1'-4"
9'-3"
#6 @ 12"
#9 @ 12"
#6 @ 12"
#5 @ 12"
#7 @ 12"
℄ HWY. 212
EX. HIGHWAY 212 BRIDGE
EL. 739.67
6
2'-0"
45'-0"
24" IMPERVIOUS FILL
1'-4"
35'-0"
2'-0"
DESIGN W.S.
9'-3"
#9 @ 12"
#6 @ 12"
#6 @ 12"
#7 @ 12"
9'-3"
WEEP HOLES @ 40'O.C.
EXISTING CHANNEL BOTTOM EL. 728.9
VARIES
4'-0"
EL. 725.88
45
#6 @ 12"
SECTION 6 / 5/118
SCALE: 3/8"=1'-0"
12" 0 1 2 3 4 5
SCALE IN FEET

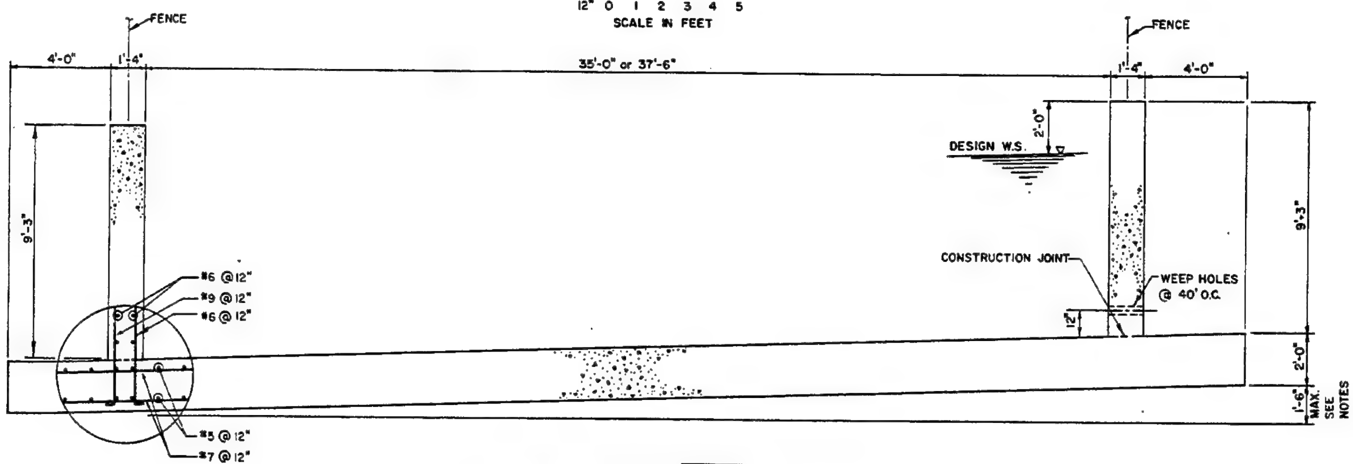
(1)



TYPICAL SECTION 4/TYP 48

SCALE: 3/8" = 1'-0"

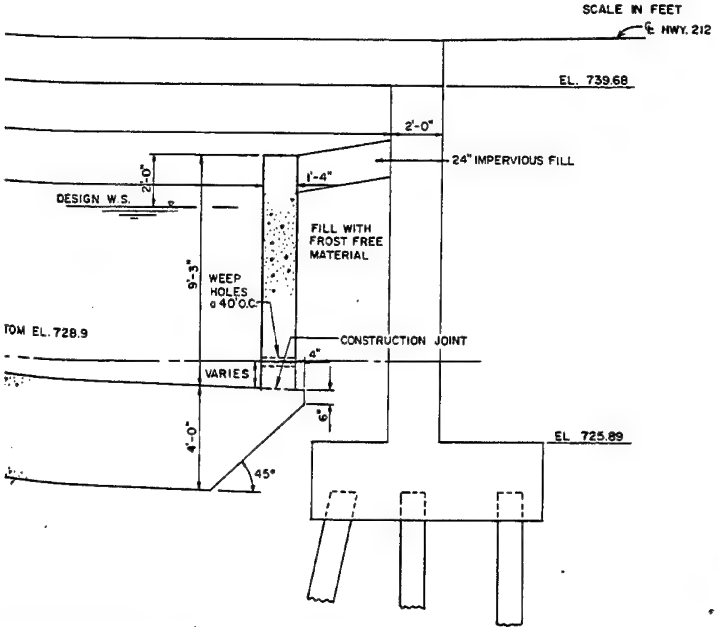
12" 0 1 2 3 4 5
SCALE IN FEET



TYPICAL SECTION 5/5/115-119

SCALE: 3/8" = 1'-0"

12" 0 1 2 3 4 5
SCALE IN FEET



REFERENCES

1. FOR SEEPAGE CONTROL AND FROST PROTECTION, SEE DRAWING 5/141
2. FENCE SEE DETAIL DRAWING 5/141
3. WEEP HOLES AND FLAP GATE SEE DRAWING 5/141
4. FOR JOINTS SEE DETAIL DRAWING 5/141
5. FOR SUPERELEVATION SEE DRAWING 5/115 THRU 5/119

SYMBOL	DESCRIPTION	DATE	APPROVAL

BONESTROO, ROSENE, ANDERLIK & ASSOC., INC.
CONSULTING ENGINEERS
St. Paul, Minnesota

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

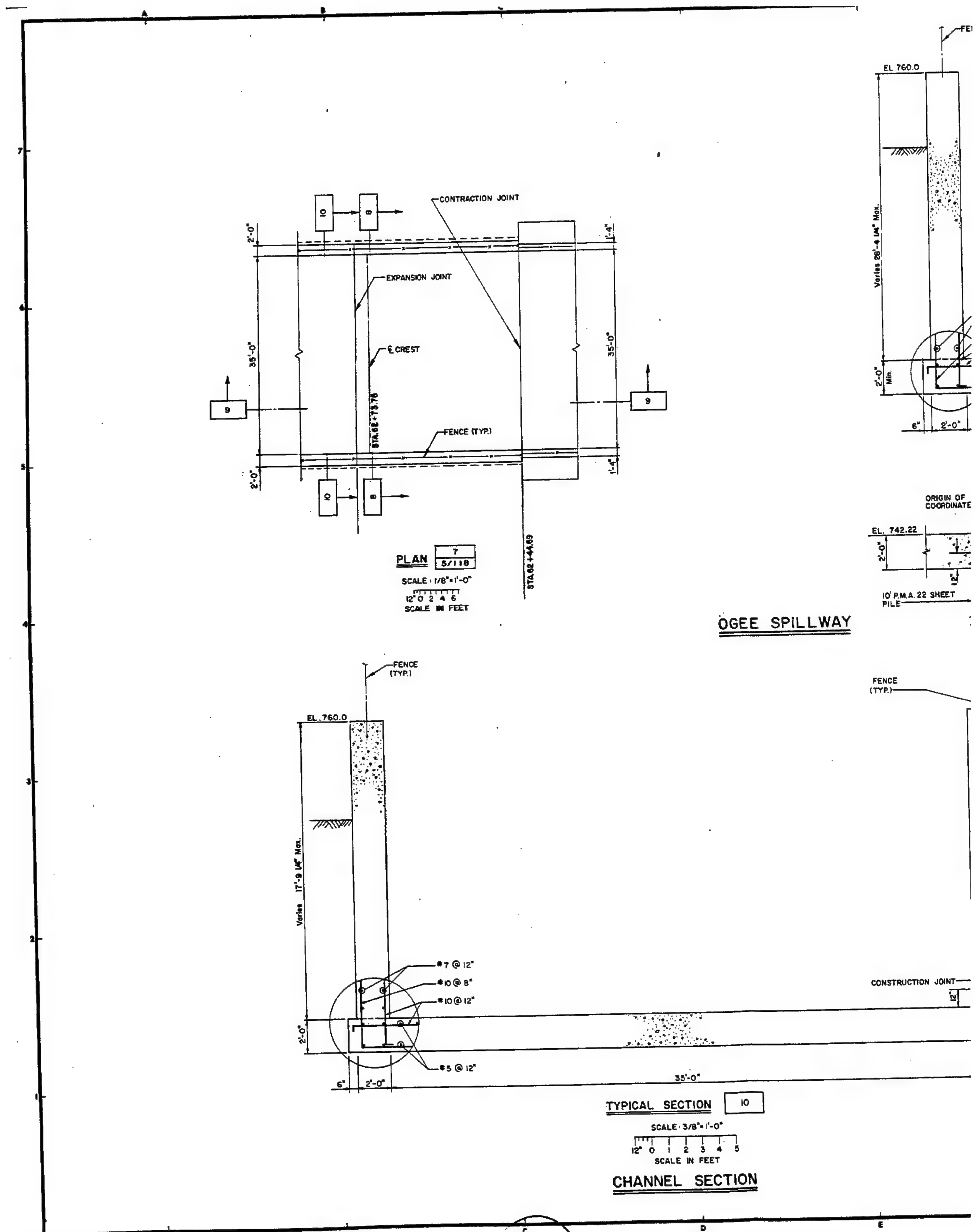
DESIGNED BY: KAB
DRAWN BY: KRL
CHECKED BY: MTR
SUBMITTED BY: [signature]

FLOOD CONTROL
FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
CHASKA CREEK
TYPICAL CHANNEL SECTIONS

APPROVED: [signature]

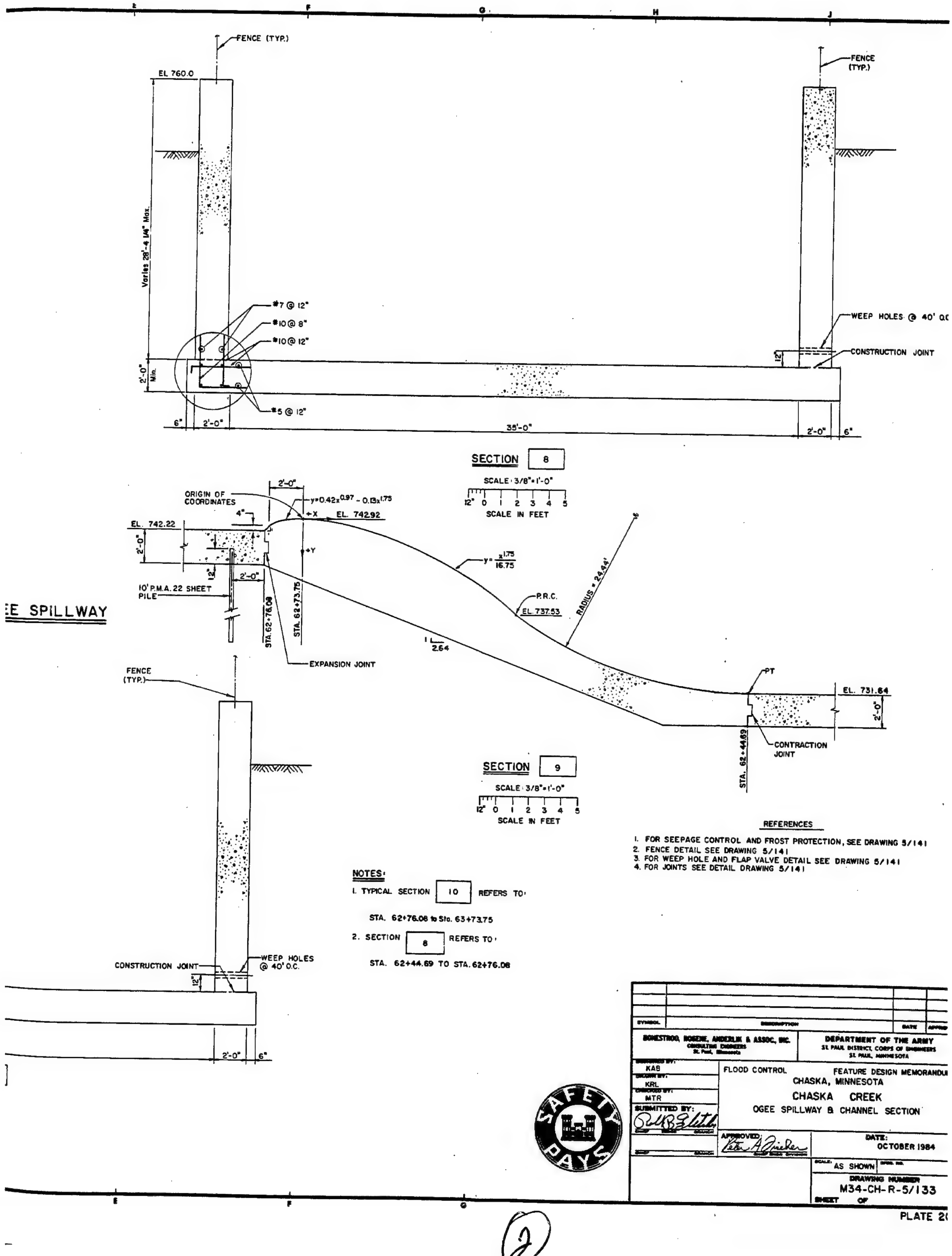
DATE: OCTOBER 1984
SCALE: AS SHOWN
SPEC. NO.
DRAWING NUMBER M34-CH-R-5/132
SHEET OF

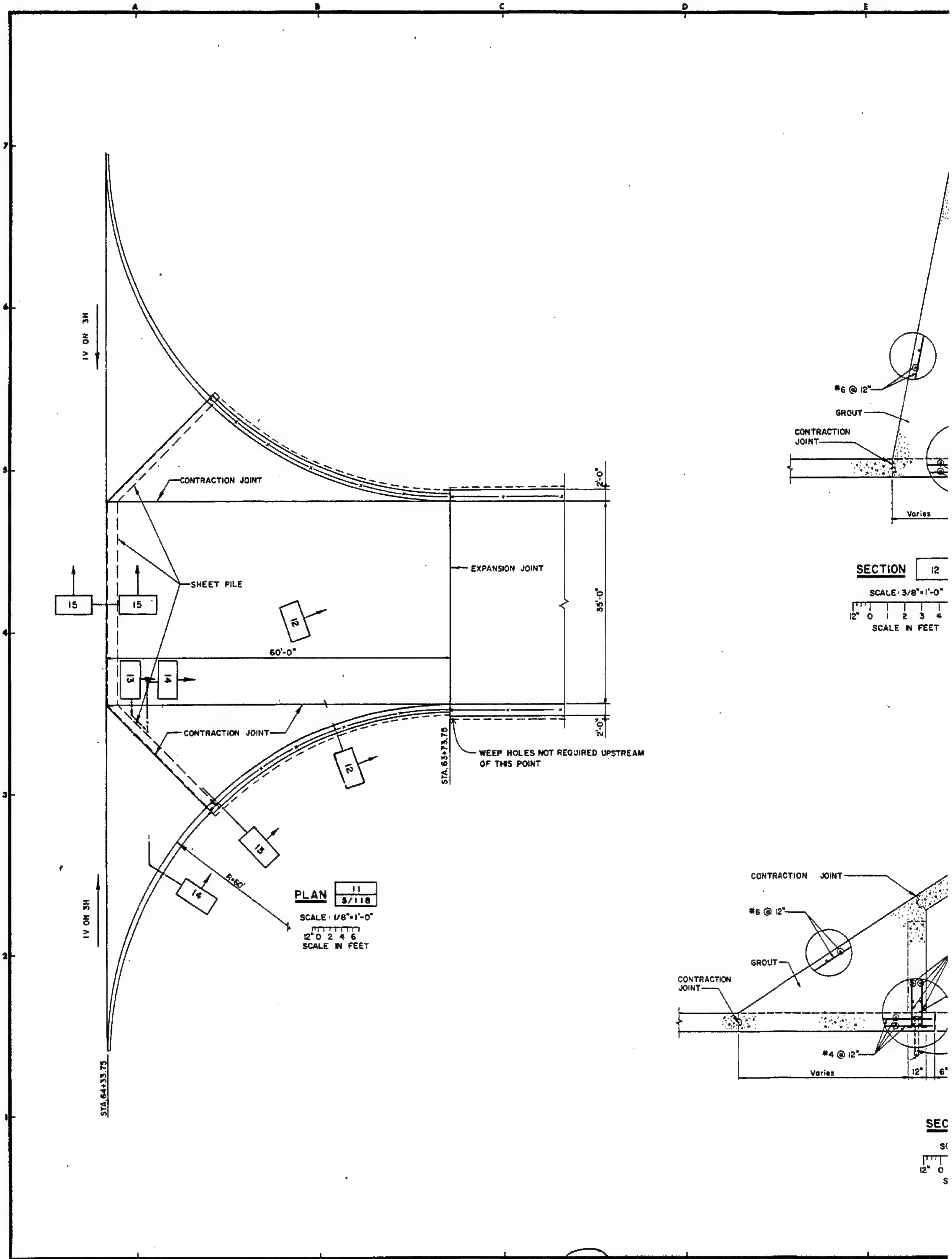
PLATE 19



CONTRACTION JOINT
EXPANSION JOINT
℄ CREST
FENCE (TYP.)
STA.62+73.78
STA.62+44.69
2'-0"
1'-4"
35'-0"
9
10
8
PLAN 7/5/118
SCALE: 1/8"=1'-0"
12" 0 2 4 6
SCALE IN FEET
OGEE SPILLWAY
EL 760.0
Varies 28'-4 1/4" Max.
2'-0" Min.
6"
ORIGIN OF COORDINATE
EL. 742.22
12"
10' P.M.A. 22 SHEET PILE
FENCE (TYP.)
EL. 760.0
Varies 17'-9 1/4" Max.
#7 @ 12"
#10 @ 8"
#10 @ 12"
#5 @ 12"
CONSTRUCTION JOINT
TYPICAL SECTION 10
SCALE: 3/8"=1'-0"
12" 0 1 2 3 4 5
SCALE IN FEET
CHANNEL SECTION

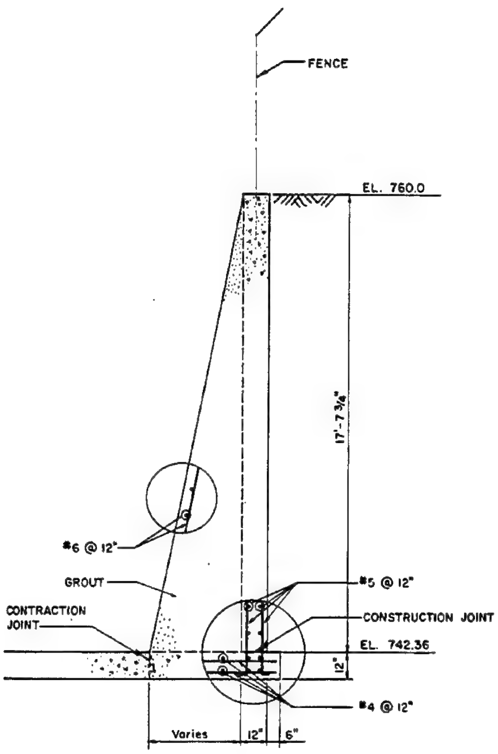
1


FENCE (TYP.)
EL 760.0
Varies 28'-4 1/4" Max.
#7 @ 12"
#10 @ 8"
#10 @ 12"
#5 @ 12"
2'-0" Min.
6"
2'-0"
35'-0"
2'-0"
6"
FENCE (TYP.)
WEEP HOLES @ 40' O.C.
CONSTRUCTION JOINT
12"
SECTION 8
SCALE: 3/8"=1'-0"
12" 0 1 2 3 4 5
SCALE IN FEET
ORIGIN OF COORDINATES
2'-0"
y=0.42x^0.97 - 0.13x^1.75
+X
EL. 742.92
EL. 742.22
4"
2'-0"
12"
2'-0"
+Y
y = x^1.75 / 16.75
10' P.M.A. 22 SHEET PILE
P.R.C.
EL. 737.53
RADIUS = 24.44'
1 / 2.64
STA. 62+76.08
STA. 62+73.75
EXPANSION JOINT
PT
EL. 731.64
2'-0"
CONTRACTION JOINT
STA. 62+44.69
E SPILLWAY
FENCE (TYP.)
SECTION 9
SCALE: 3/8"=1'-0"
12" 0 1 2 3 4 5
SCALE IN FEET
REFERENCES
1. FOR SEEPAGE CONTROL AND FROST PROTECTION, SEE DRAWING 5/141
2. FENCE DETAIL SEE DRAWING 5/141
3. FOR WEEP HOLE AND FLAP VALVE DETAIL SEE DRAWING 5/141
4. FOR JOINTS SEE DETAIL DRAWING 5/141
NOTES:
1. TYPICAL SECTION 10 REFERS TO:
STA. 62+76.08 to Sta. 63+73.75
2. SECTION 8 REFERS TO:
STA. 62+44.69 TO STA. 62+76.08
CONSTRUCTION JOINT
WEEP HOLES @ 40' O.C.
12"
2'-0"
6"
SYMBOL
DESCRIPTION
DATE
BONESTROO, ROSENE, ANDERLIK & ASSOC., INC.
CONSULTING ENGINEERS
St. Paul, Minnesota
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
KAB
KRL
MTR
SUBMITTED BY:
FLOOD CONTROL
FEATURE DESIGN MEMORANDU
CHASKA, MINNESOTA
CHASKA CREEK
OGEE SPILLWAY & CHANNEL SECTION
APPROVED:
DATE:
OCTOBER 1984
SCALE: AS SHOWN
DRAWING NUMBER
M34-CH-R-5/133
SHEET OF
SAFETY PAYS
PLATE 2(
2



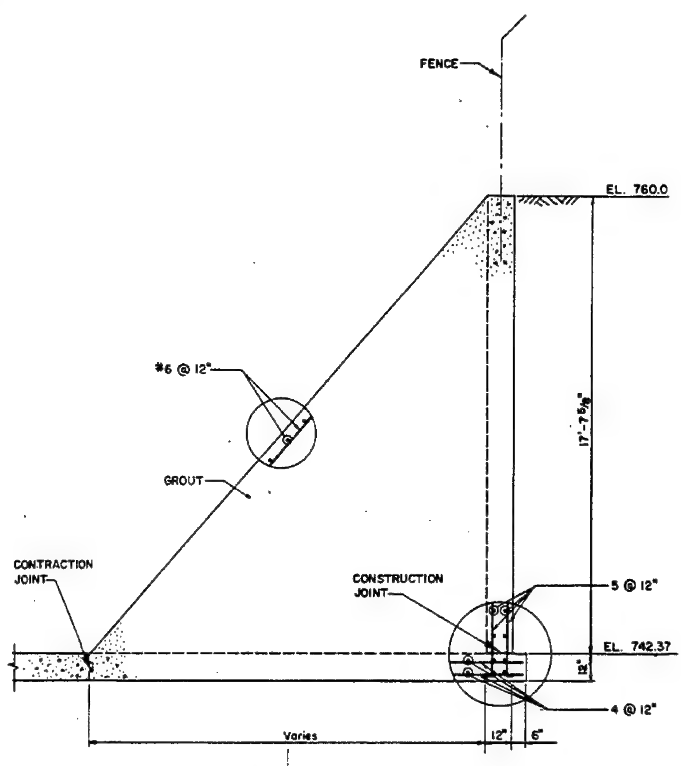
1V ON 3H
CONTRACTION JOINT
SHEET PILE
EXPANSION JOINT
15
12
13
14
60'-0"
35'-0"
2'-0"
STA.63+73.75
WEEP HOLES NOT REQUIRED UPSTREAM OF THIS POINT
R=60'
PLAN 11 5/118
SCALE: 1/8"=1'-0"
12" 0 2 4 6
SCALE IN FEET
STA.64+33.75
#6 @ 12"
GROUT
Varies
SECTION 12
SCALE: 3/8"=1'-0"
12" 0 1 2 3 4
#4 @ 12"
12"
6"
SEC

1



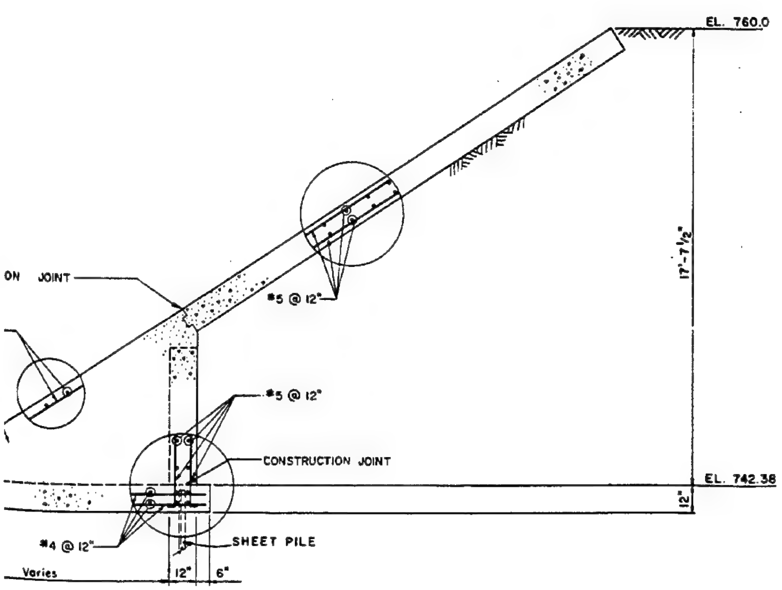
SECTION 12

SCALE: 3/8"=1'-0"



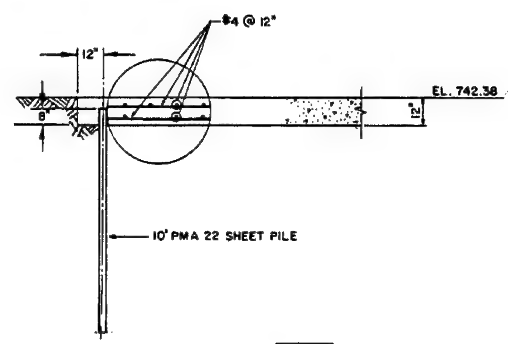
SECTION 13

SCALE: 3/8"=1'-0"



SECTION 14

SCALE: 3/8"=1'-0"



SECTION 15

SCALE: 3/8"=1'-0"

REFERENCES

1. FOR SEEPAGE CONTROL AND FROST PROTECTION SEE DRAWING 5/141
2. FENCE DETAIL SEE DRAWING 5/141
3. FOR JOINT DETAILS SEE DRAWING 5/141

SYMBOL	DESCRIPTION	DATE	APPROVAL

BONESTROO, ROSENE, ANDERLIK & ASSOC. INC.
CONSULTING ENGINEERS
St. Paul, Minnesota

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: KAB
DRAWN BY: KRL
CHECKED BY: MTR
SUBMITTED BY:

FLOOD CONTROL
FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
CHASKA CREEK
INLET STRUCTURE

APPROVED:

DATE: OCTOBER 1984

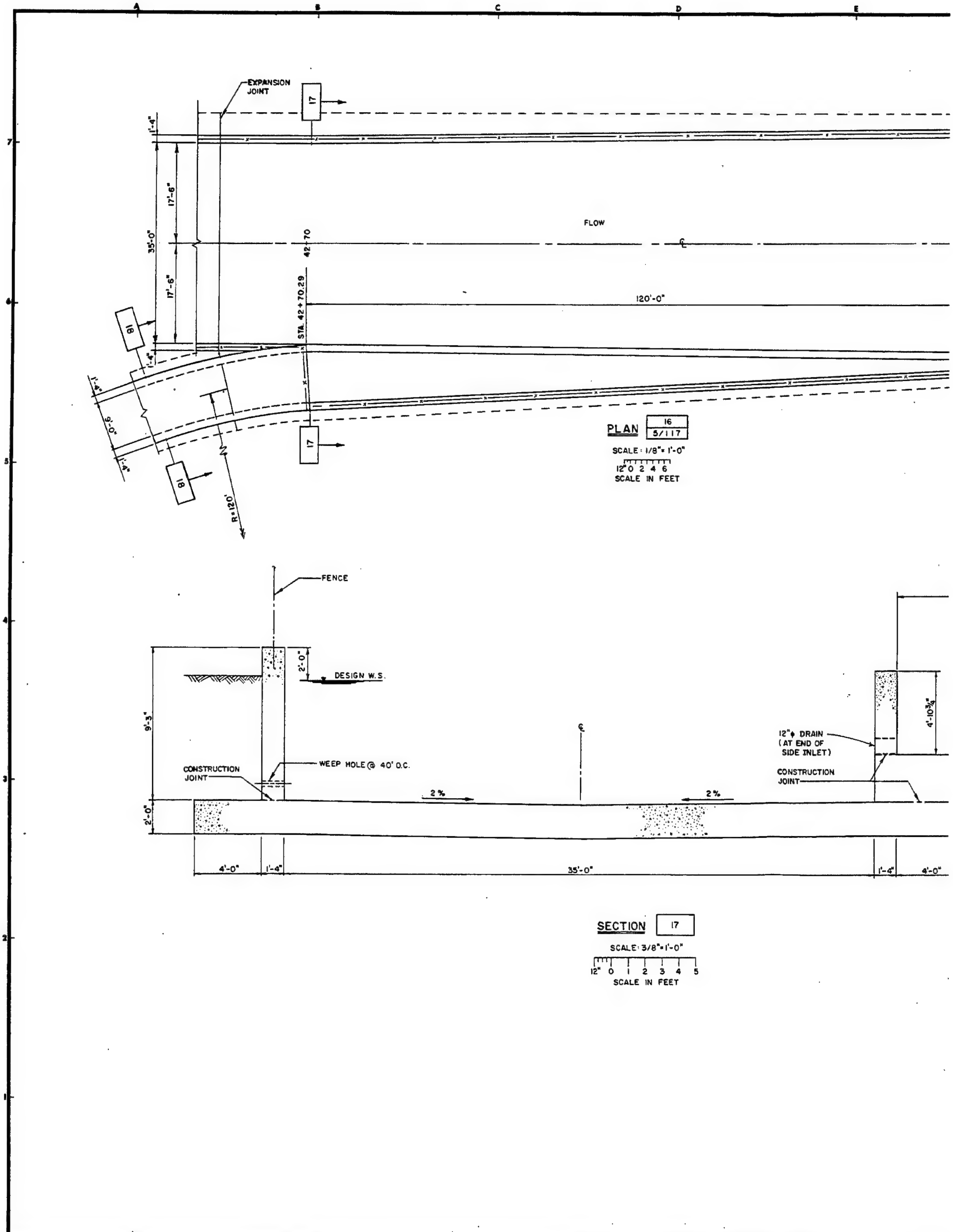
SCALE: AS SHOWN

DRAWING NUMBER
M34-CH-R-5/134

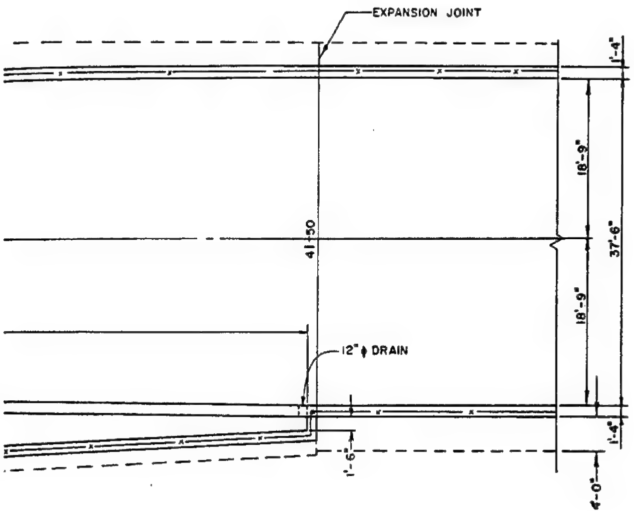
SHEET OF

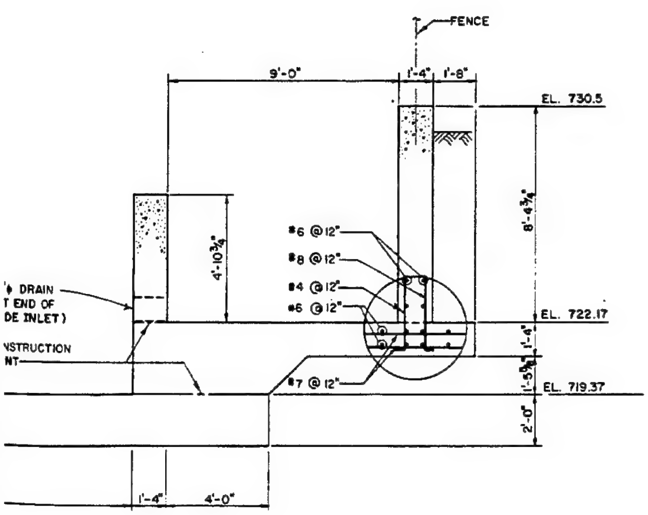
PLATE 21

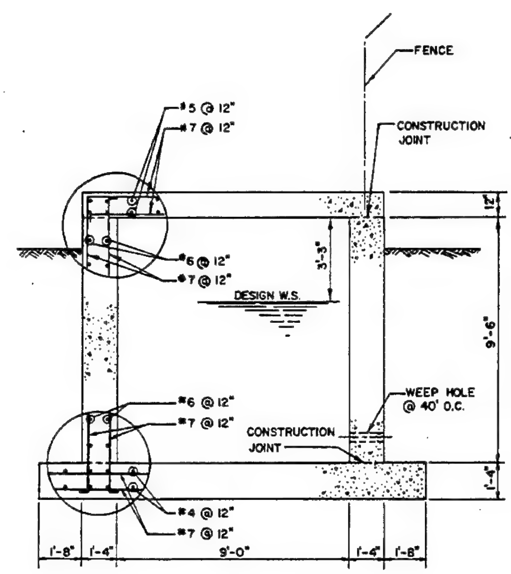
(2)


EXPANSION JOINT
17
1'-4"
17'-6"
35'-0"
17'-6"
FLOW
42+70
STA. 42+70.29
120'-0"
18
R=120'
PLAN 16 5/117
SCALE: 1/8"=1'-0"
12" 0 2 4 6
SCALE IN FEET
FENCE
2'-0"
DESIGN W.S.
9'-3"
CONSTRUCTION JOINT
WEEP HOLE @ 40' O.C.
2%
2%
2'-0"
12"ϕ DRAIN (AT END OF SIDE INLET)
4'-10¾"
CONSTRUCTION JOINT
4'-0"
1'-4"
35'-0"
1'-4"
4'-0"
SECTION 17
SCALE: 3/8"=1'-0"
12" 0 1 2 3 4 5
SCALE IN FEET

D







SECTION 18

SCALE: 3/8"=1'-0"

12" 0 1 2 3 4 5

SCALE IN FEET

REFERENCES

1. FOR SEEPAGE CONTROL AND FROST PROTECTION, SEE DRAWING 5/141
2. FENCE DETAIL SEE DRAWING 5/141
3. FOR WEEP HOLE AND FLAP VALVE DETAIL SEE DRAWING 5/141
4. FOR JOINT DETAIL SEE DRAWING 5/141

SYMBOL	DESCRIPTION	DATE	APPROVAL

BONESTROO, ROSENE, ANDERLIK & ASSOC., INC.
CONSULTING ENGINEERS
St. Paul, Minnesota

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: KAB
DRAWN BY: KRL
CHECKED BY: MTR
SUBMITTED BY: [signature]

FLOOD CONTROL — FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
CHASKA CREEK
DRAINAGE CHANNEL SIDE INLET

APPROVED: [signature]

DATE: OCTOBER 1984

SCALE: AS SHOWN

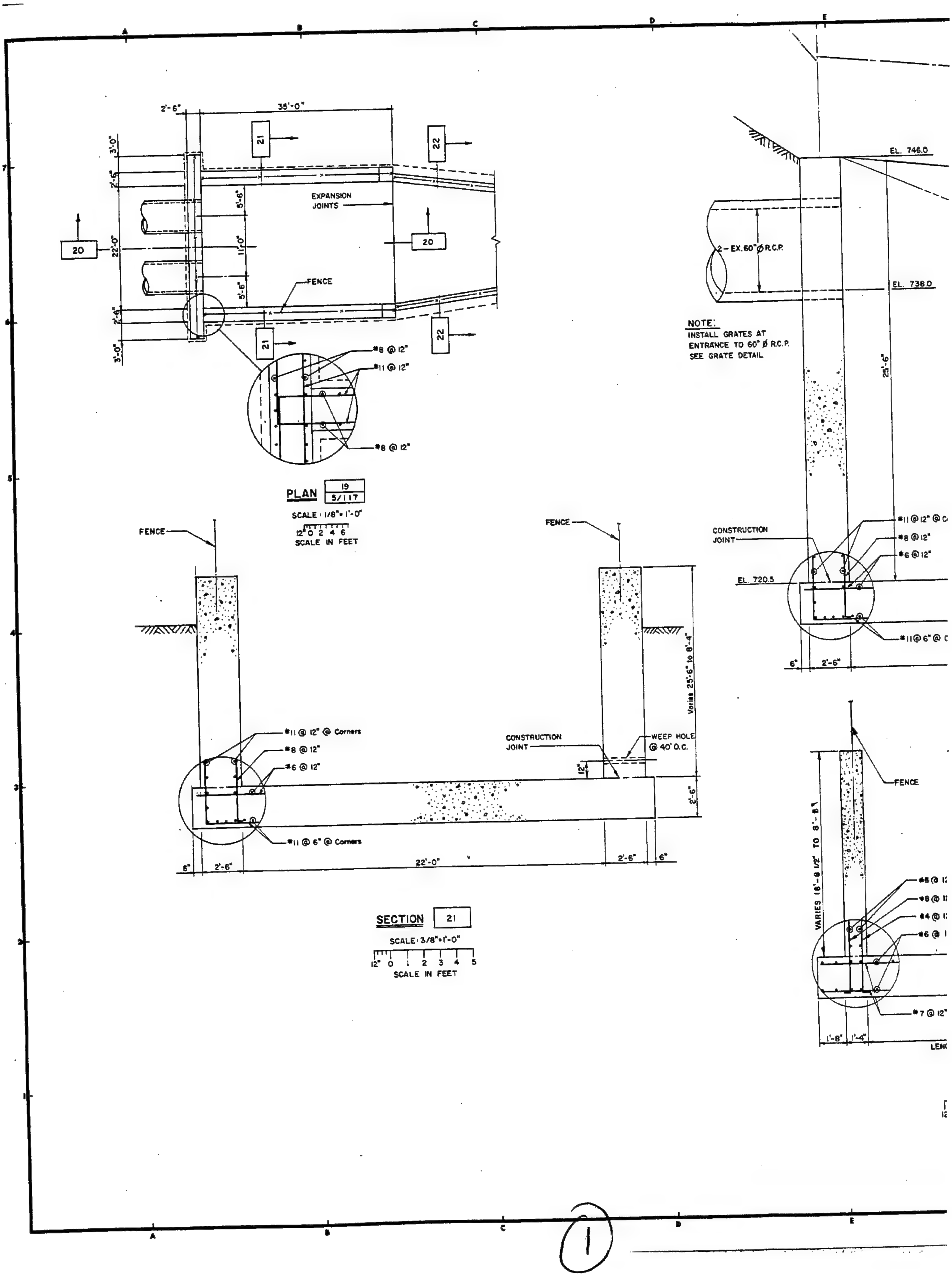
DRAWING NUMBER
M34-CH-R-5/135

SHEET OF

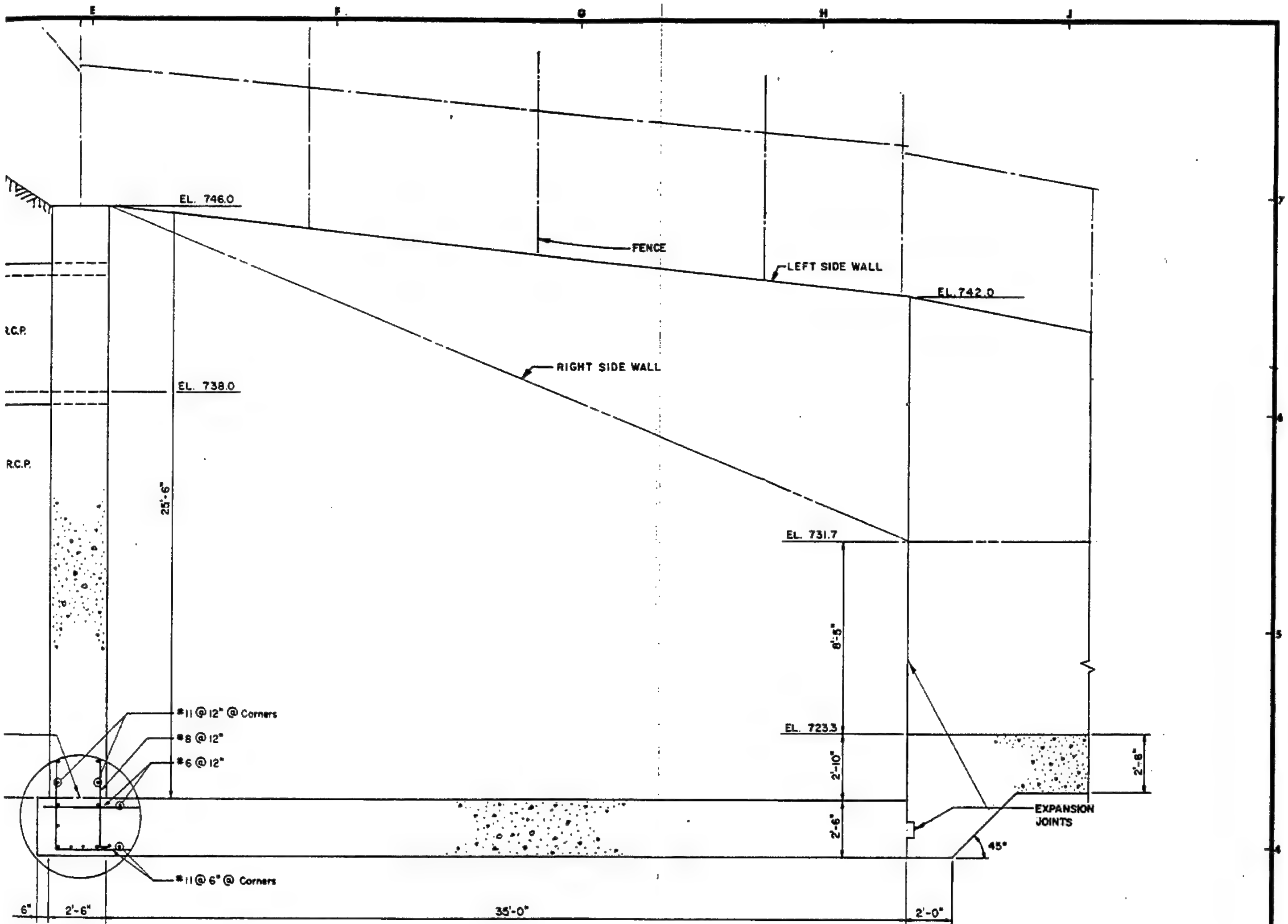
SAFETY PAYS

PLATE 22

2



2'-6"
35'-0"
3'-0"
2'-6"
22'-0"
2'-6"
3'-0"
21
22
20
EXPANSION JOINTS
5'-6"
11'-0"
5'-6"
FENCE
#8 @ 12"
#11 @ 12"
#8 @ 12"
PLAN
19
5/117
SCALE : 1/8" = 1'-0"
12" 0 2 4 6
SCALE IN FEET
EL. 746.0
2 - EX. 60" Ø R.C.P.
EL. 738.0
NOTE:
INSTALL GRATES AT ENTRANCE TO 60" Ø R.C.P.
SEE GRATE DETAIL
25'-6"
FENCE
#11 @ 12" @ Corners
#8 @ 12"
#6 @ 12"
#11 @ 6" @ Corners
CONSTRUCTION JOINT
WEEP HOLE @ 40' O.C.
12"
Varies 25'-6" to 8'-4"
2'-6"
6"
2'-6"
22'-0"
2'-6"
6"
SECTION
21
SCALE : 3/8" = 1'-0"
12" 0 1 2 3 4 5
SCALE IN FEET
CONSTRUCTION JOINT
#11 @ 12" @ C
#8 @ 12"
#6 @ 12"
EL. 720.5
#11 @ 6" @ C
6"
2'-6"
FENCE
VARIES 18'-8 1/2" TO 8'-8"
#6 @ 1
#8 @ 1
#4 @ 1
#6 @ 1
#7 @ 12"
1'-8"
1'-4"
LEN
1

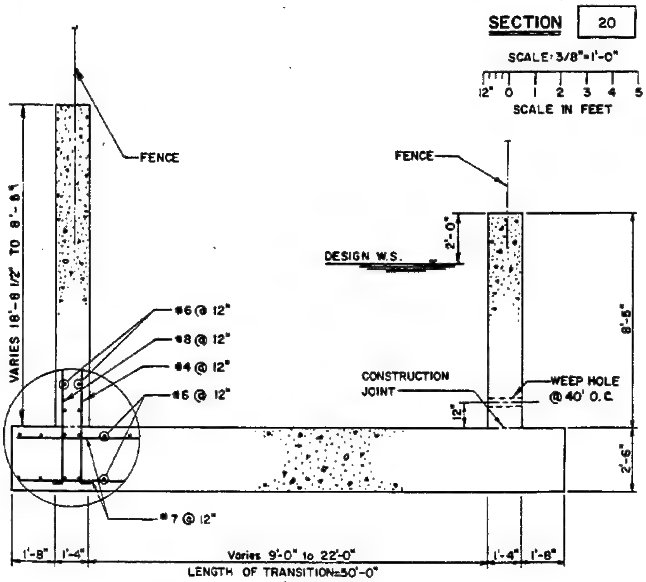


SECTION 20

SCALE: 3/8"=1'-0"

12" 0 1 2 3 4 5

SCALE IN FEET



SECTION 22

SCALE: 3/8"=1'-0"

12" 0 1 2 3 4 5

SCALE IN FEET

REFERENCES

1. FOR SEEPAGE CONTROL AND FROST PROTECTION, SEE DRAWING 5/141
2. FENCE DETAIL SEE DRAWING 5/141
3. FOR WEEP HOLE AND FLAP VALVE DETAIL SEE DRAWING 5/141
4. FOR JOINT DETAILS SEE DRAWING 5/141
5. FOR GRATE DETAIL SEE DRAWING 5/141

SAFETY PAYS

SYMBOL	DESCRIPTION	DATE	APPROVAL

BONESTROO, ROSENE, ANDERLIK & ASSOC., INC.
CONSULTING ENGINEERS
St. Paul, Minnesota

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: KAB
DRAWN BY: KRL, J.M.J.
CHECKED BY: MTR
SUBMITTED BY: [signature]

FLOOD CONTROL — FEATURE DESIGN MEMORANDUM

CHASKA, MINNESOTA

CHASKA CREEK

DRAINAGE CHANNEL DROP STRUCTURE

APPROVED: [signature]

DATE: OCTOBER 1984

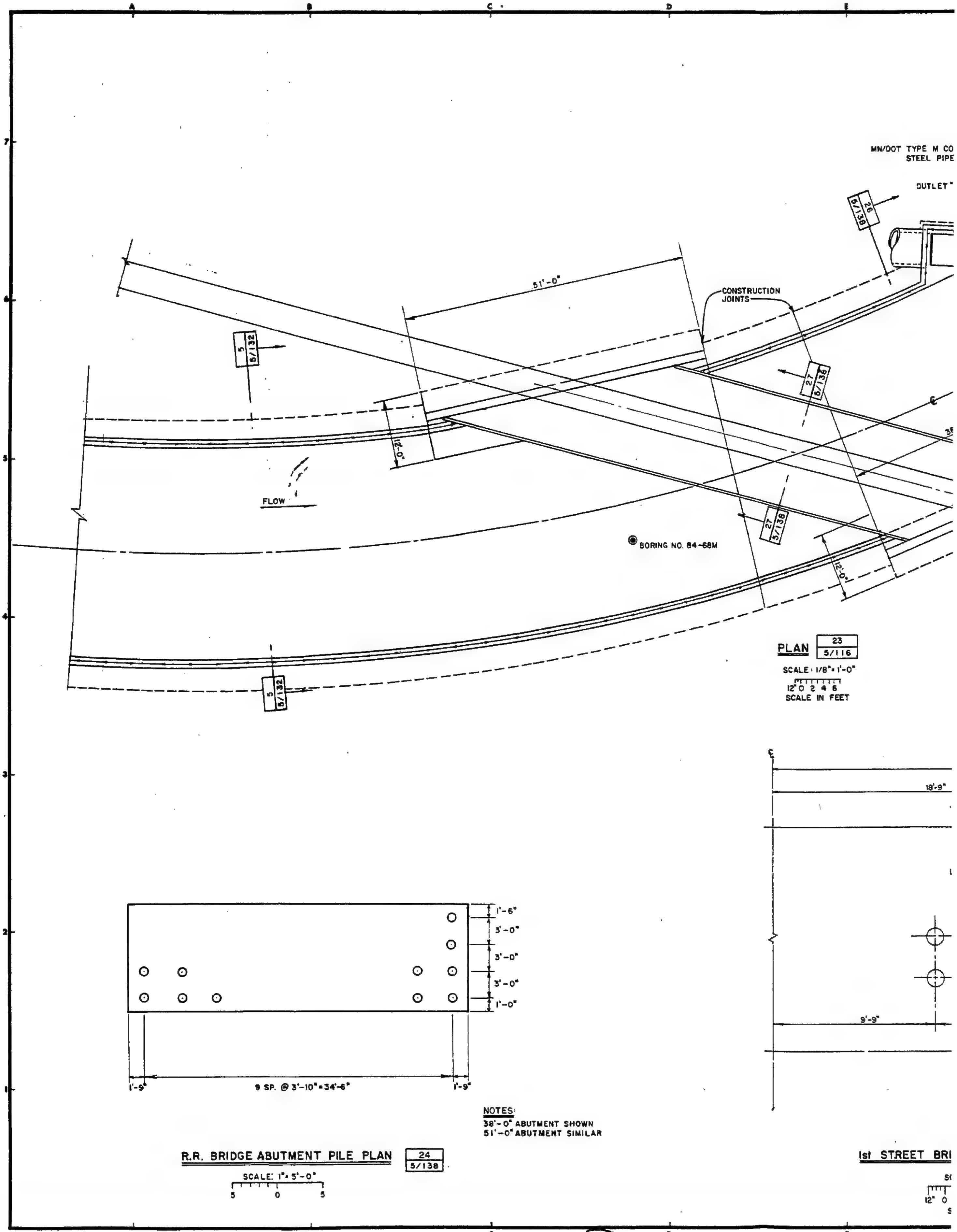
SCALE: AS SHOWN

DRAWING NUMBER: M34-CH-R-5/136

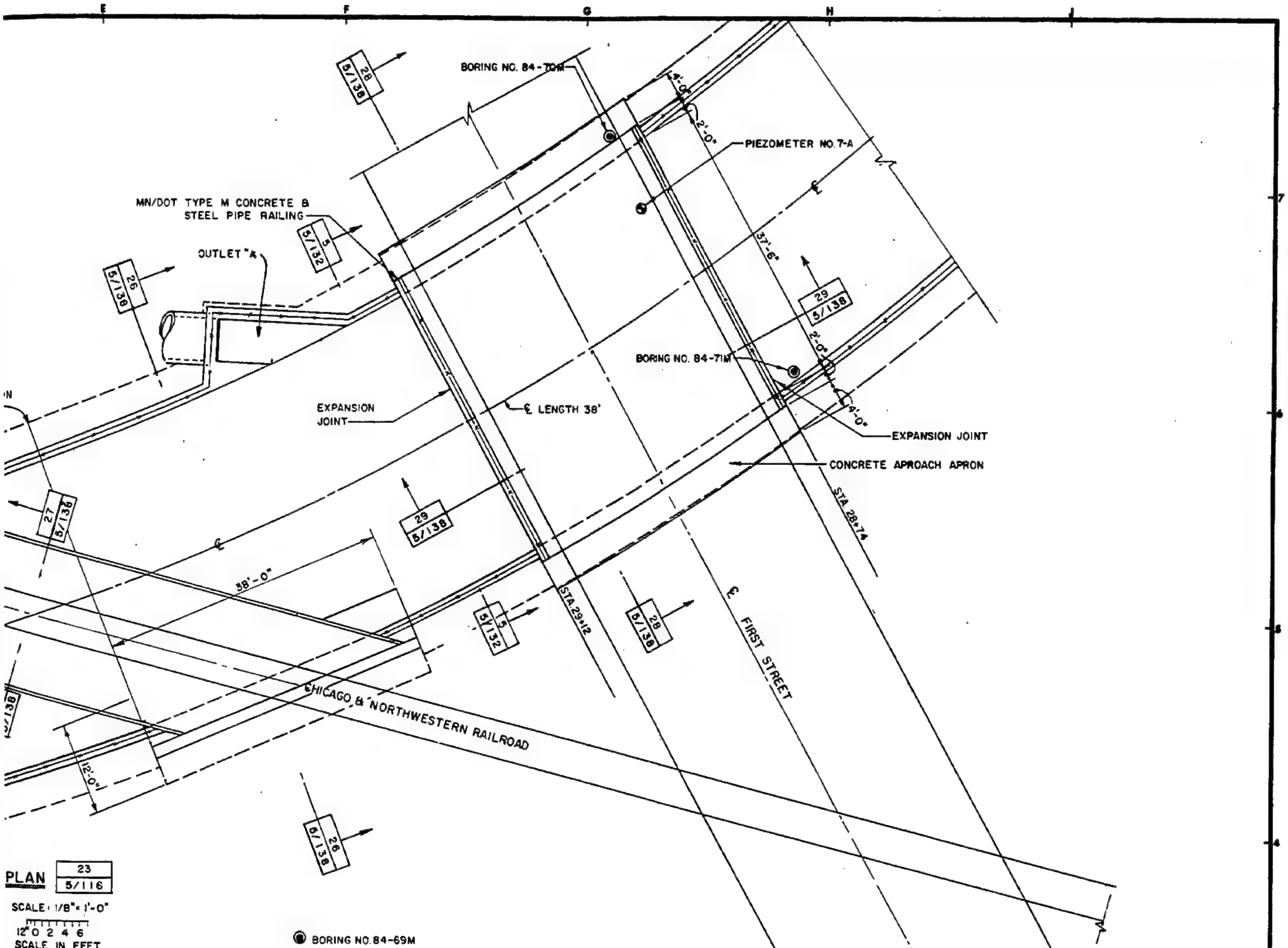
SHEET OF

PLATE 23

2



MN/DOT TYPE M CO
STEEL PIPE
OUTLET
26 5/138
51'-0"
CONSTRUCTION JOINTS
5 5/132
27 5/136
12'-0"
FLOW
BORING NO. 84-68M
27 5/138
12'-0"
PLAN 23 5/116
SCALE: 1/8" = 1'-0"
12" 0 2 4 6
SCALE IN FEET
5 5/132
18'-9"
9'-9"
1'-6"
3'-0"
3'-0"
3'-0"
1'-0"
1'-9"
9 SP. @ 3'-10" = 34'-6"
1'-9"
NOTES:
38'-0" ABUTMENT SHOWN
51'-0" ABUTMENT SIMILAR
R.R. BRIDGE ABUTMENT PILE PLAN 24 5/138
SCALE: 1" = 5'-0"
5 0 5
1st STREET BRI

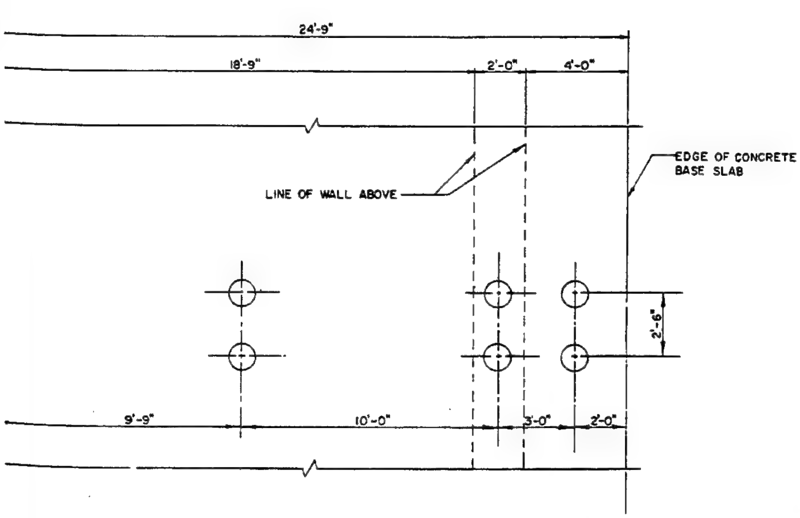


PLAN 23 / 5/116

SCALE: 1/8" = 1'-0"

SCALE IN FEET

BORING NO. 84-69M



REFERENCES

1. FOR SEEPAGE CONTROL AND FROST PROTECTION, SEE DRAWING 5/141
2. FENCE DETAIL SEE DRAWING 5/141
3. FOR JOINT DETAILS SEE DRAWING 5/141

NOTES:
SAME PILE PATTERN, REPEAT ALL ALONG 1st STREET BRIDGE-BOTH SIDES

1st STREET BRIDGE PILE PLAN 25 / 5/138

SCALE: 3/8" = 1'-0"

SCALE IN FEET

BONESTROO, ROSENE, ANDERLIK & ASSOC., INC. CONSULTING ENGINEERS St. Paul, Minnesota

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: KAB
DRAWN BY: KRL
CHECKED BY: MTR
SUBMITTED BY:

FLOOD CONTROL FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
CHASKA CREEK
RAILROAD/1st STREET BRIDGE

APPROVED:

DATE: OCTOBER 1984

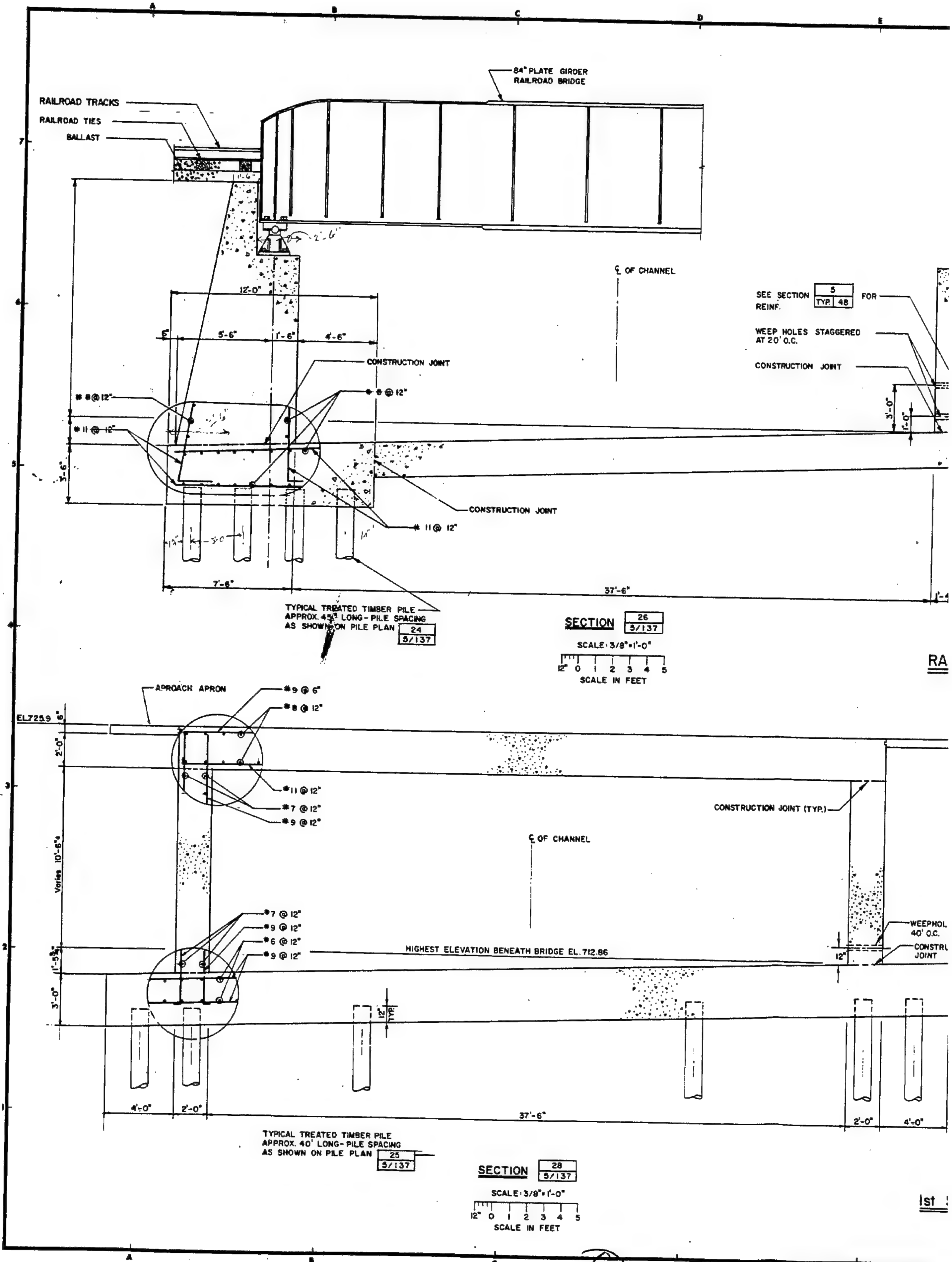
SCALE: AS SHOWN

DRAWING NUMBER M34-CH-R-5/137

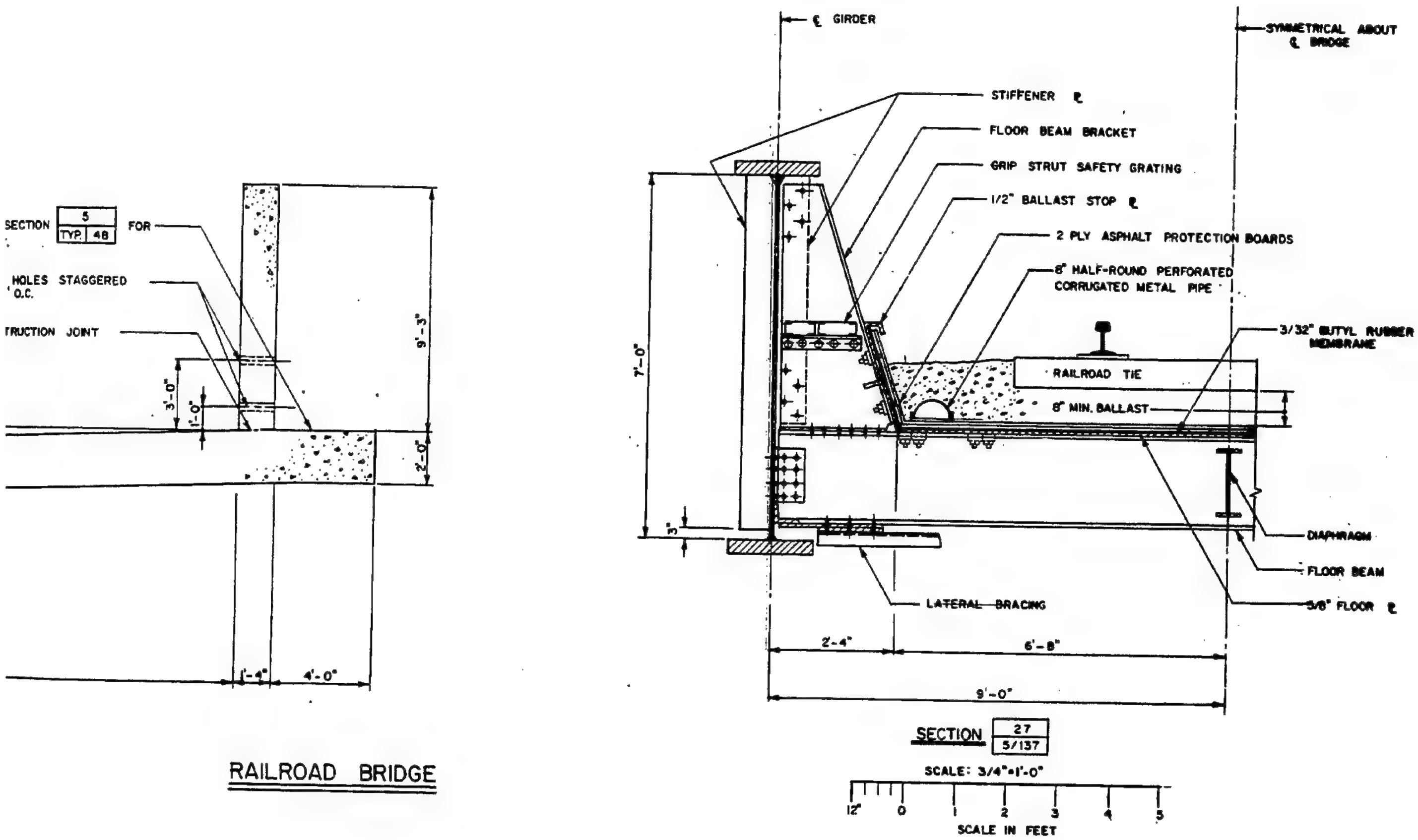
SHEET OF

PLATE 24

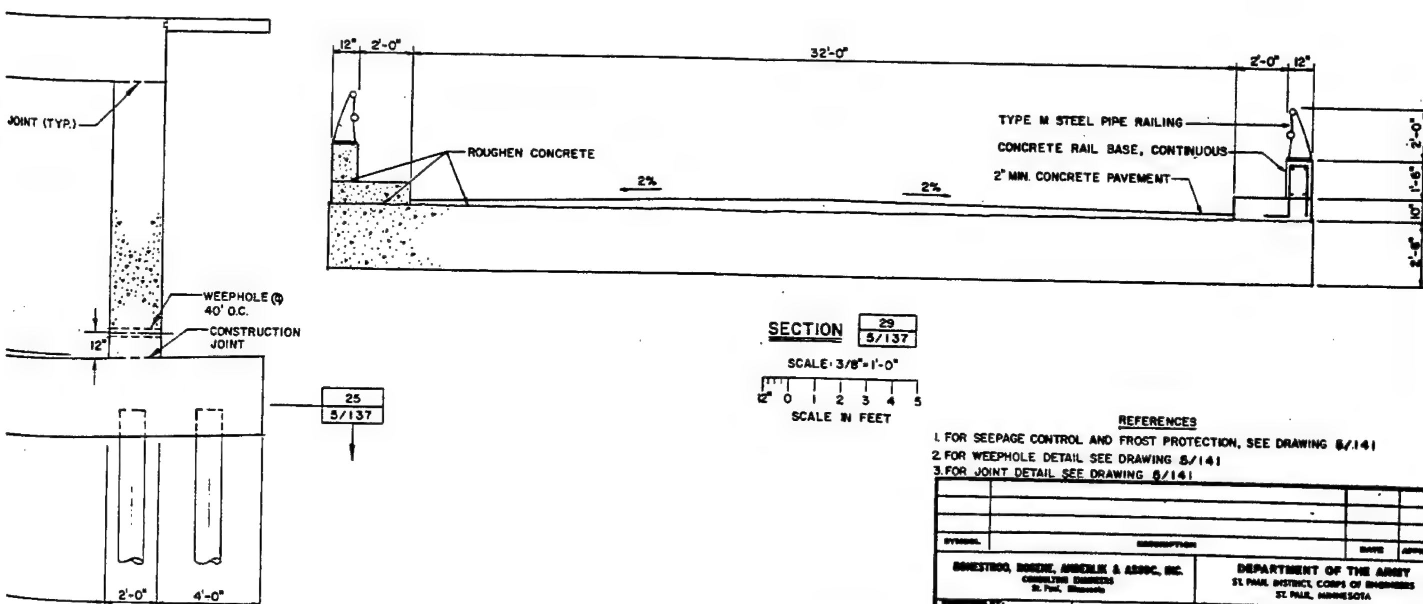
(2)


84" PLATE GIRDER RAILROAD BRIDGE
RAILROAD TRACKS
RAILROAD TIES
BALLAST
2'-6"
℄ OF CHANNEL
SEE SECTION 5/TYP. 48 FOR REINF.
WEEP HOLES STAGGERED AT 20' O.C.
CONSTRUCTION JOINT
12'-0"
5'-6"
1'-6"
4'-6"
CONSTRUCTION JOINT
#8@12"
#6 @ 12"
#11 @ 12"
3'-6"
3'-0"
1'-0"
CONSTRUCTION JOINT
#11 @ 12"
7'-6"
37'-6"
TYPICAL TREATED TIMBER PILE APPROX. 45' LONG-PILE SPACING AS SHOWN ON PILE PLAN 24/5/137
SECTION 26/5/137
SCALE: 3/8"=1'-0"
12" 0 1 2 3 4 5
SCALE IN FEET
RA
APROACH APRON
#9 @ 6"
#8 @ 12"
EL.725.9
6"
2'-0"
#11 @ 12"
#7 @ 12"
#9 @ 12"
CONSTRUCTION JOINT (TYP.)
℄ OF CHANNEL
Varies 10'-6"±
#7 @ 12"
#9 @ 12"
#6 @ 12"
#9 @ 12"
HIGHEST ELEVATION BENEATH BRIDGE EL. 712.86
WEEPHOL 40' O.C.
CONSTRU JOINT
12"
1'-5"
3'-0"
12" TYP.
4'-0"
2'-0"
37'-6"
2'-0"
4'-0"
TYPICAL TREATED TIMBER PILE APPROX. 40' LONG-PILE SPACING AS SHOWN ON PILE PLAN 25/5/137
SECTION 28/5/137
SCALE: 3/8"=1'-0"
12" 0 1 2 3 4 5
SCALE IN FEET
1st

1



RAILROAD BRIDGE



1st STREET BRIDGE

REFERENCES

1. FOR SEEPAGE CONTROL AND FROST PROTECTION, SEE DRAWING 5/141
2. FOR WEEPHOLE DETAIL SEE DRAWING 5/141
3. FOR JOINT DETAIL SEE DRAWING 5/141

SYMBOL	DESCRIPTION	DATE	APPROVAL

BONESTROO, ROSENE, ANDERLIK & ASSOC., INC.
CONSULTING ENGINEERS
St. Paul, Minnesota

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: KAB
DRAWN BY: KRL
CHECKED BY: MTR
SUBMITTED BY:

FLOOD CONTROL
FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
CHASKA CREEK
RAILROAD/1st STREET BRIDGE

APPROVED:

DATE: OCTOBER 1984

SCALE: AS SHOWN

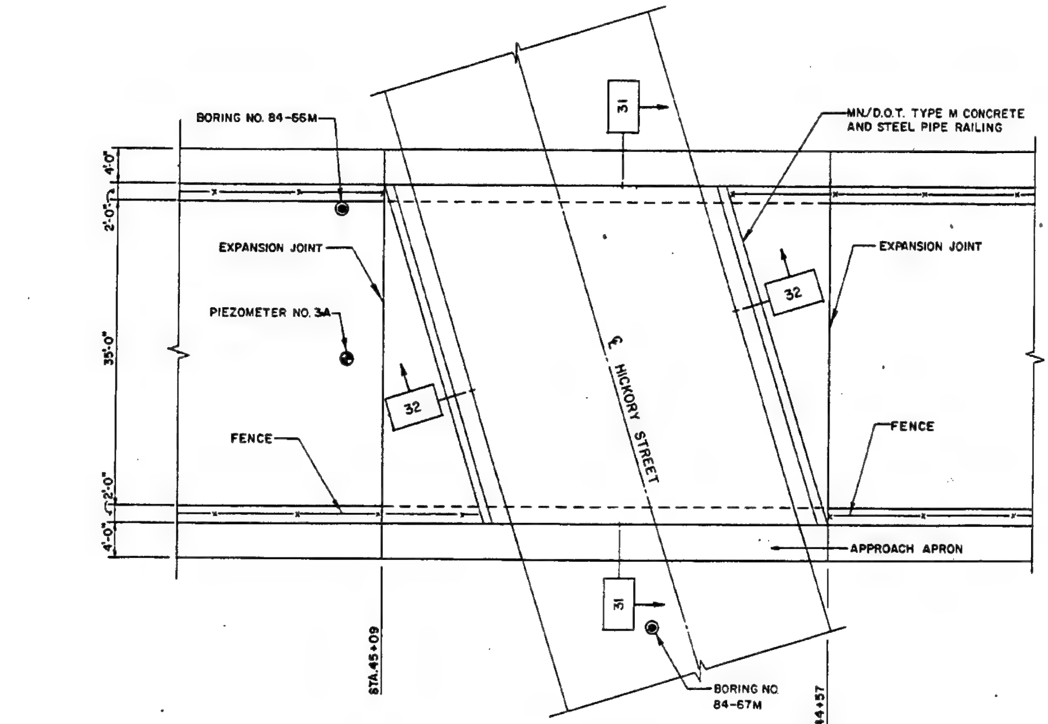
DRAWING NUMBER
M34-CH-R-5/136

SHEET OF

PLATE 25

SAFETY PAYS

(2)

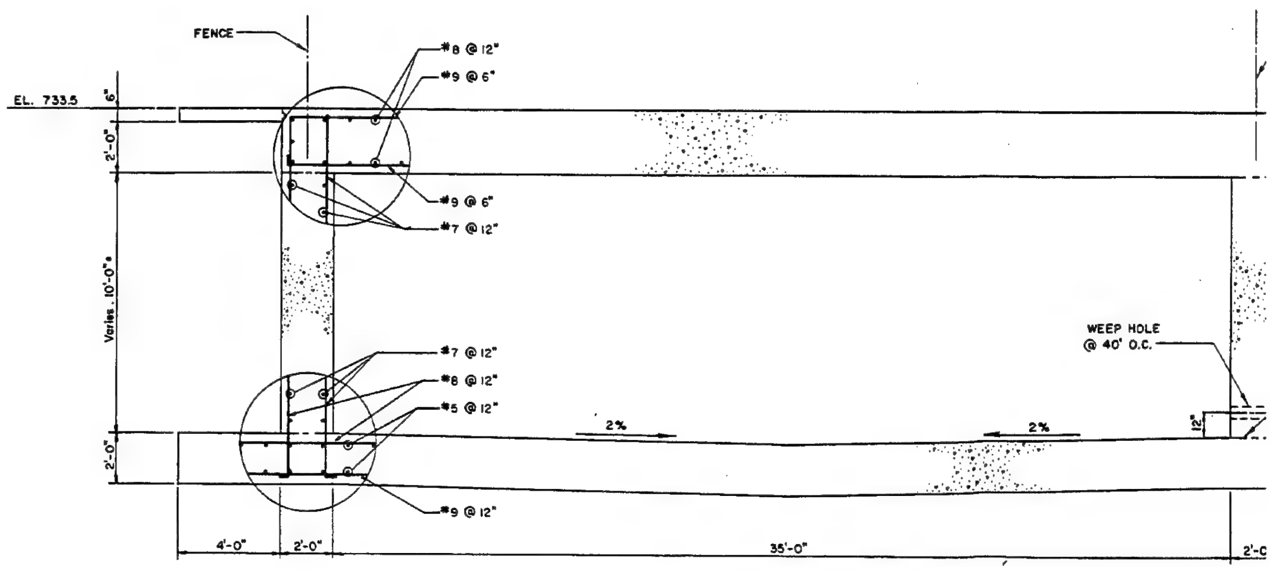


PLAN 30 / 5/117

SCALE: 1/8" = 1'-0"

12" 0 2 4 6

SCALE IN FEET



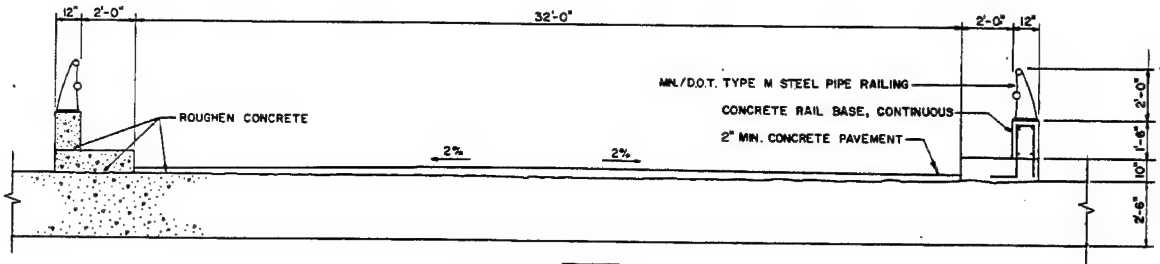
SECTION 31

SCALE: 3/8" = 1'-0"

12" 0 1 2 3 4 5

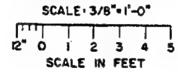
SCALE IN FEET

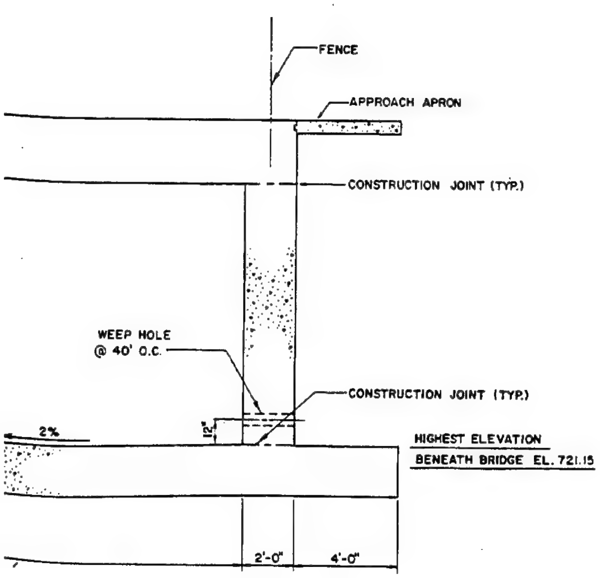
(1)



SECTION 32

SCALE: 3/8"=1'-0"





REFERENCES

1. FOR SEEPAGE CONTROL AND FROST PROTECTION, SEE DRAWING 5/141
2. FENCE DETAIL SEE DRAWING 5/141
3. FOR WEEP HOLE AND FLAP VALVE DETAIL SEE DRAWING 5/141
4. FOR JOINT DETAILS SEE DRAWING 5/141

SYMBOL	DESCRIPTION	DATE	APPROVAL

BONESTROO, ROSENE, ANDERLIK & ASSOC., INC.
CONSULTING ENGINEERS
St. Paul, Minnesota

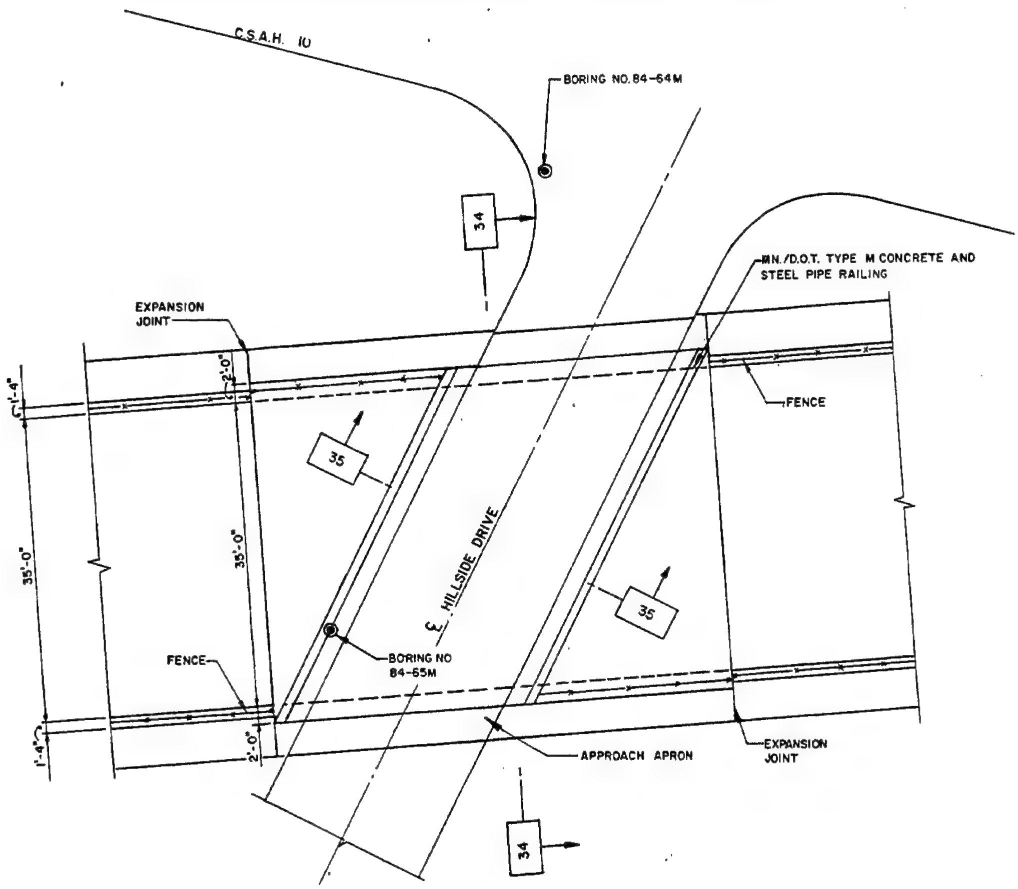
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: KAB
DRAWN BY: KRL
CHECKED BY: MTR
SUBMITTED BY:

FLOOD CONTROL FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
CHASKA CREEK
HICKORY STREET BRIDGE

APPROVED BY: Peter A Fischer
CHIEF, ENGR. DIVISION

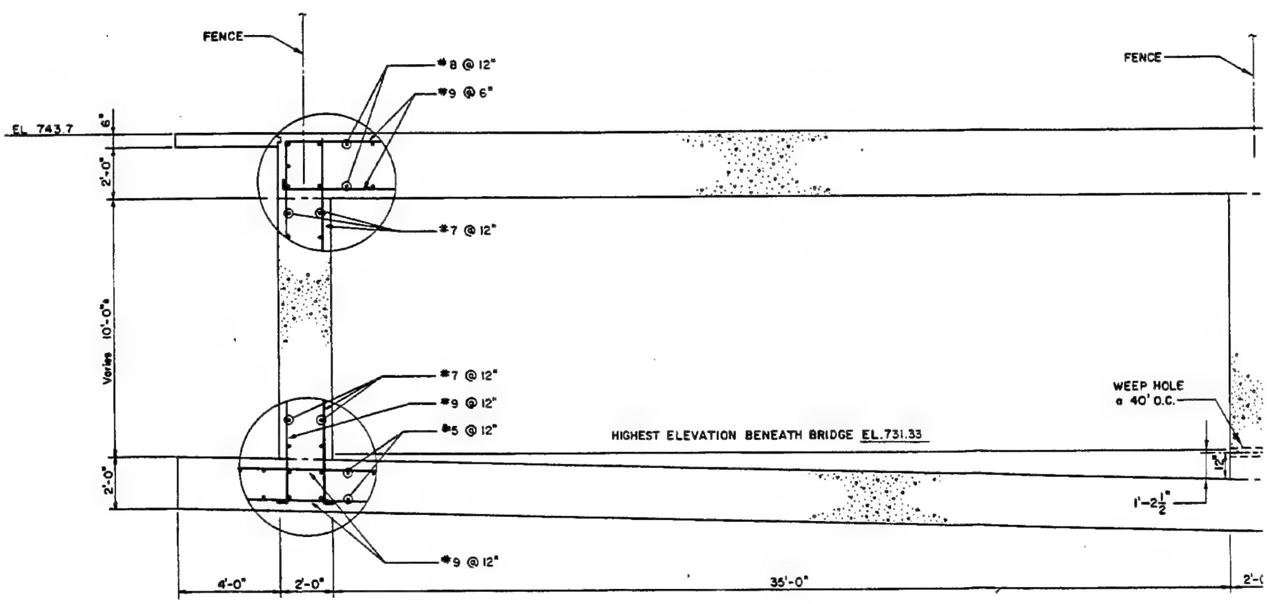
DATE: OCTOBER 1964
SCALE: AS SHOWN
DRAWING NUMBER M34-CH-R-5/139



PLAN 33 5/118

SCALE: 1/8" = 1'-0"

12" 0 2 4 6
SCALE IN FEET

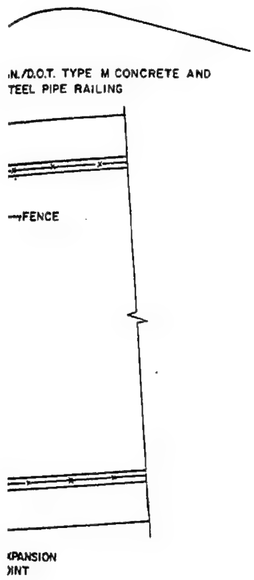


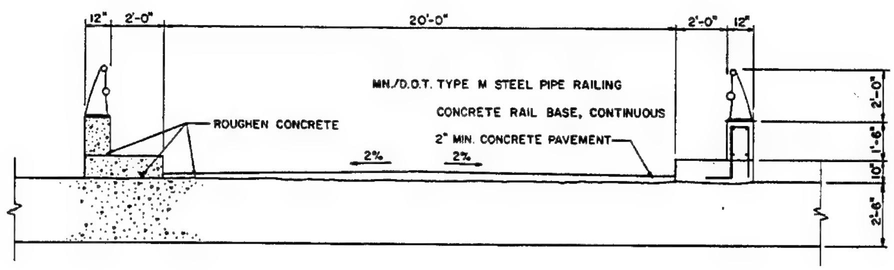
SECTION 34

SCALE: 3/8" = 1'-0"

12" 0 1 2 3 4 5
SCALE IN FEET

1



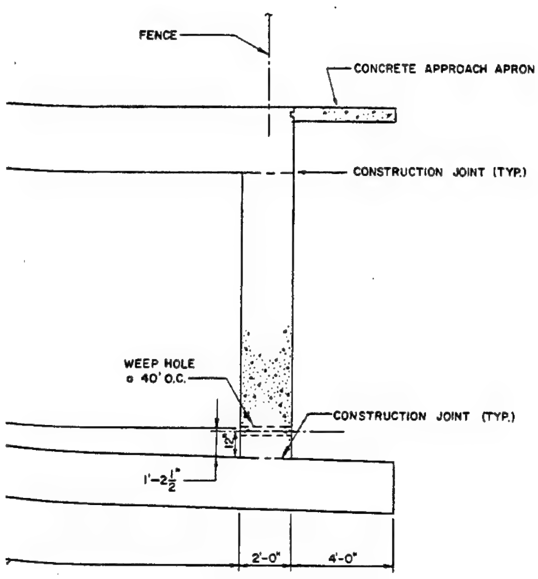


SECTION 35

SCALE: 3/8"=1'-0"

12" 0 1 2 3 4 5

SCALE IN FEET



REFERENCES

1. FOR SEEPAGE CONTROL AND FROST PROTECTION, SEE DRAWING 5/141
2. FENCE DETAIL SEE DRAWING 5/141
3. FOR WEEP HOLE AND FLAP VALVE DETAIL SEE DRAWING 5/141
4. FOR JOINT DETAIL SEE DRAWING 5/141

SYMBOL	DESCRIPTION	DATE	APPROVAL

BONESTROO, ROSENE, ANDERLIK & ASSOC., INC.
CONSULTING ENGINEERS
St. Paul, Minnesota

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: KAB
DRAWN BY: KRL, J.M.J.
CHECKED BY: MTR
SUBMITTED BY:

FLOOD CONTROL FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
CHASKA CREEK
HILLSIDE DRIVE BRIDGE

APPROVED BY:

DATE: OCTOBER 1984

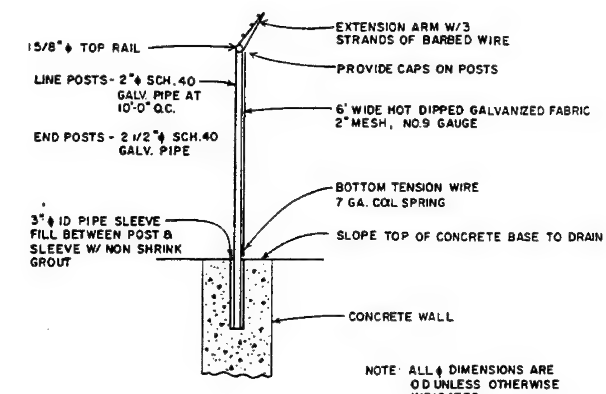
SCALE: AS SHOWN

DRAWING NUMBER: M34-CH-R-5/140

SHEET OF

PLATE 27

2



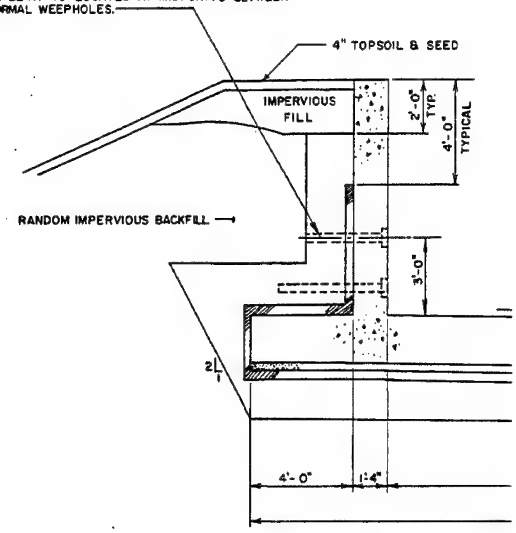
NOTE: ALL ϕ DIMENSIONS ARE O.D UNLESS OTHERWISE INDICATED.

TYPICAL FENCE DETAIL | 36

0 1 2 3 4 5 6
SCALE IN FEET
SCALE: 1/2" = 1'-0"

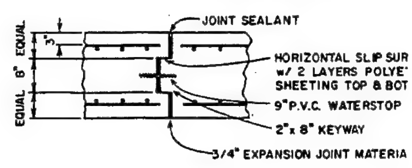
NOTE

ADDITIONAL ROW OF WEEPHOLES TO BE INSTALLED FROM STA. 29+14 TO STA. 42+00 ON THE NORTH SIDE OF CHANNEL. WEEPHOLES TO BE AT 40' LOCATED AT MIDPOINTS BETWEEN NORMAL WEEPHOLES.



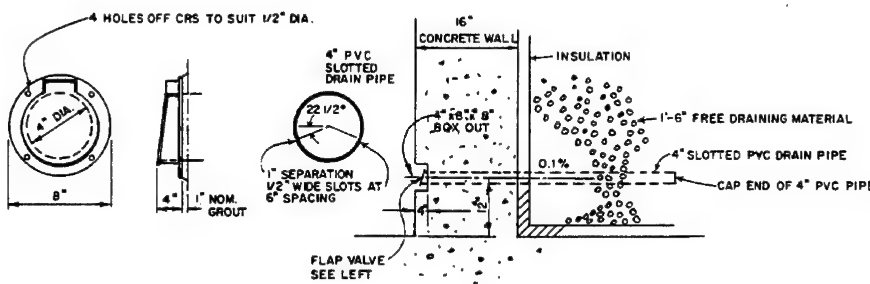
NOTES

1. JOINTS AT 40'
2. REINF. NOT CONTINUOUS ACROS
3. EXPANSION MATERIAL TO BE F



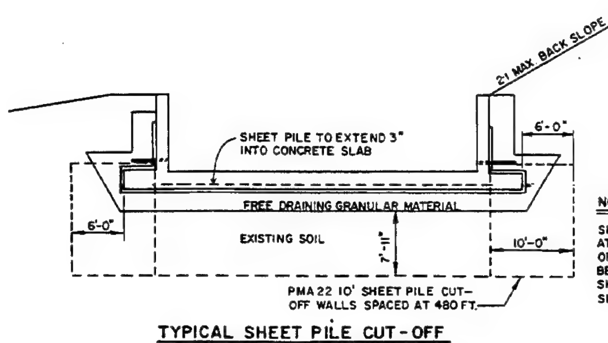
KEYED JOINT DETAIL

0 1 2 3 4
SCALE IN FEET
SCALE: 3/4" = 1'-0"



WEEP HOLE DRAIN AND FLAP VALVE DETAIL | 38

NO SCALE

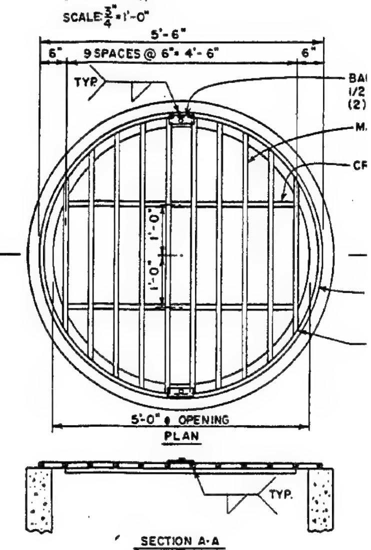


NOTE

SHEET PILES TO BE PLACED AT JOINTS, OUTSIDE 10 FEET OF SHEET PILE WALL, SHALL BE THRU CONCRETE, AND SHALL BE 13 FEET LONG EACH SIDE.

TYPICAL SHEET PILE CUT-OFF

0 1 2 3 4 5 6 7 8
SCALE IN FEET
SCALE: 1/8" = 1'-0"



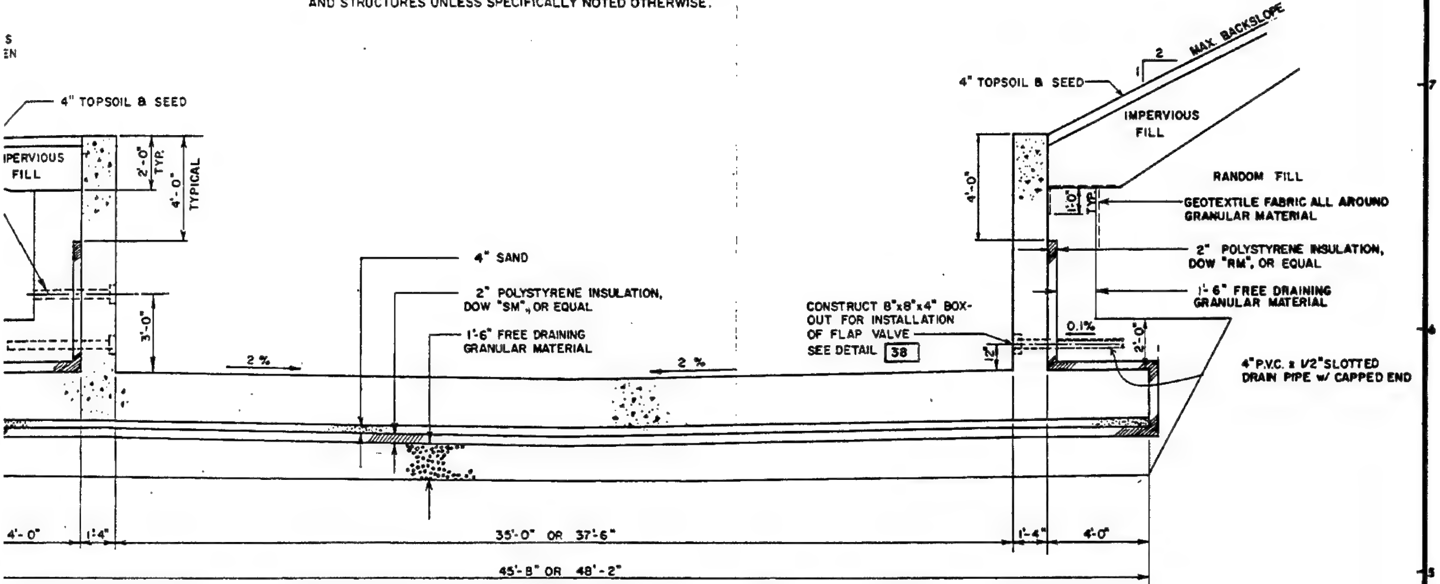
GRATE DETAIL | 42

0 1 2 3 4
SCALE IN FEET
SCALE: 3/4" = 1'-0"

1

NOTE

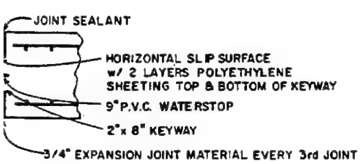
THE FROST PROTECTION AND SEEPAGE CONTROL ELEMENTS OF THIS TYPICAL DETAIL APPLY TO ALL CHANNEL SECTIONS AND STRUCTURES UNLESS SPECIFICALLY NOTED OTHERWISE.



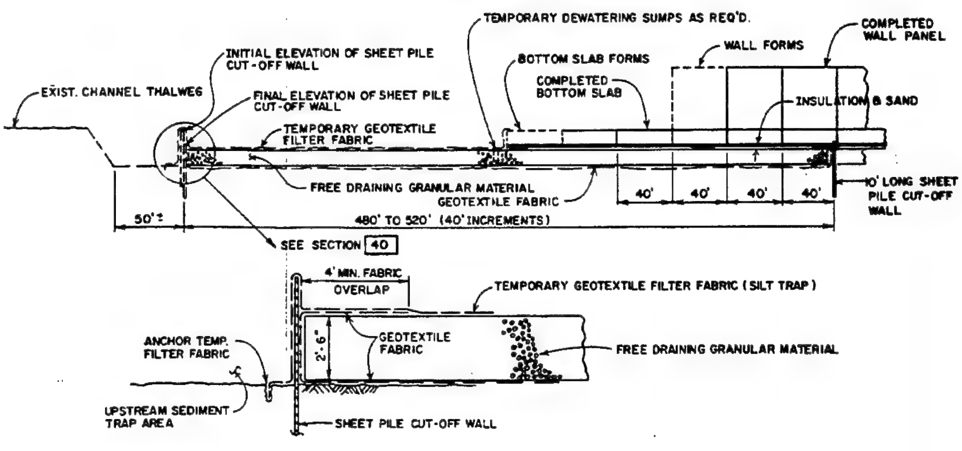
TYPICAL CHANNEL CROSS SECTION
SEEPAGE CONTROL AND FROST PROTECTION DETAIL

SCALE IN FEET
SCALE: 3/8"=1'-0"

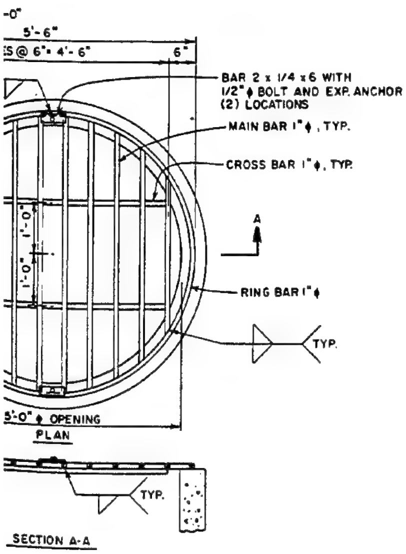
NOTES
1. JOINTS AT 40'
2. REINF. NOT CONTINUOUS ACROSS KEYED JOINT.
3. EXPANSION MATERIAL TO BE PLACED EVERY 3rd JOINT.



T DETAIL



TYPICAL CONSTRUCTION SEQUENCING SECTION 40
NO SCALE



RATE DETAIL 42

SCALE IN FEET
SCALE: 3/4"=1'-0"

SYMBOL	DESCRIPTION	DATE	APPROVAL

BONESTROO, ROSENE, ANDERLIK & ASSOC., INC. CONSULTING ENGINEERS St. Paul, Minnesota

DEPARTMENT OF THE ARMY ST. PAUL DISTRICT, CORPS OF ENGINEERS ST. PAUL, MINNESOTA

DESIGNED BY: MRR
DRAWN BY: TGB
CHECKED BY: MTR
SUBMITTED BY:

FLOOD CONTROL FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
CHASKA CREEK
DETAILS

APPROVED:
DATE: OCTOBER 1984
SCALE: AS SHOWN
DRAWING NUMBER M34-CH-R-5/141
SHEET OF

PLATE 28

(2)

APPENDIX A

HYDRAULICS AND INTERIOR FLOOD CONTROL

APPENDIX A

HYDRAULICS AND INTERIOR FLOOD CONTROL

TABLE OF CONTENTS

INTERIOR FLOOD CONTROL

TABLES

PLATES

HYDRAULIC DESIGN

GENERAL

1. This appendix covers the hydraulic design of only those portions of the Chaska Flood Control Project that are included in this feature design memorandum. This includes the Chaska Creek channel modification and the levee adjacent to Chaska Creek. The hydraulic design for East Creek and for the rest of the levee is presented in the previous general design memorandum and will be finalized in future feature design memorandums. The Chaska Creek channel modification includes two control structures and a concrete supercritical flow channel. Changes in the present design from that presented in the general design memorandum are finalization of the details of the proposed debris barrier and of the proposed weep holes, revised alignments for the side drainage inlets and a shortened and slightly revised alignment for the channel. The levee along the left side of the proposed Chaska Creek alignment is designed to protect the city from Minnesota River flooding and has not been changed from the general design memorandum design.

HYDRAULIC DESIGN
MINNESOTA RIVER

2. The hydraulic design for the proposed Minnesota River levee has not been changed from the general design memorandum. The proposed levee will provide protection from the 1-percent chance flood. Full details for the hydraulic design of the proposed levee are presented in the limited reevaluation report. The design of the top of levee profile is briefly reviewed here. The proposed top of levee profile was developed by selecting a discharge from the rating curve at the downstream end of the project 3 feet above the computed design water surface profile then backwatering this discharge. Because of the wide floodplain at Chaska and backwater effects from the Mississippi River, the computed profile for this discharge attenuates in the upstream direction. This results in a difference between the computed design water surface profile and the computed profile for this discharge at the upstream end of the project of 2.84 feet. The proposed top of levee profile shown in this report was adjusted so that the levee elevation is not less than 3 feet above the computed design water surface profile at any place along the levee to insure overtopping at the downstream end as discussed in the limited reevaluation report. The consequences of overtopping would be minimized since the city has an emergency plan and there is significant warning time if the levees are going to be overtopped. Other details for the Minnesota River at Chaska such as existing water surface profiles can be found in the limited reevaluation report.

HYDRAULIC DESIGN
CHASKA CREEK

GENERAL

2. The proposed design for Chaska Creek consists of an ogee inlet structure, a 0.8 mile long concrete rectangular channel and a Saint Anthony Falls type stilling basin at the outlet. The channel is designed to provide protection from the standard project flood on Chaska Creek, the design discharge is 5550 cfs upstream of the drainage inlet at channel station 42+00 and 6040 cfs downstream of this inlet. The concrete channel is to flow supercritical with the same alignment as the general design memorandum. The inlet ogee structure and approach channel are designed to provide a smooth entrance into the supercritical channel and to raise the lowered water surface and channel bottom in the project area to match the pre-project existing conditions water surfaces and thalweg upstram of the project. The outlet stilling basin is designed to dissipate the excess energy of the supercritcal flow and provide a reliable control at the downstream end of the channel.

DESCRIPTION OF PROJECT

4. Outlet Structure. The outlet structure consists of a parabolic drop into a Saint Anthony Falls type stilling basin with a preformed scour hole downstream, as shown on plates 3, 12 and 18. The SAF basin was selected because it performs very well for varying discharges and fluctuating tailwater. Tailwater elevations were obtained by backwatering from the Minnesota River to the outlet structure. The design tailwater assumes a low pool elevation on the Minnesota River, 688.0, and the creek SPF discharge of 6040 cfs. No degradation of the riprapped outlet channel and tailwater elevation is anticipated. The tailwater and conjugate tailwater elevations are shown on plate A-1. The required tailwater depth used was $0.9d_2$ due to the forces exerted by the baffle blocks and end sill which reduce the required tailwater for a jump. This allows a higher bottom elevation which yields a more economical design with improved jump stability during periods of moderately high tailwater.

5. The required top elevation of the training walls (719.0) is equal to the maximum tailwater for which the jump will remain in the basin under the SPF flow conditions in Chaska Creek. The top of the wall is set at the conjugate depth of the supercritical flow at the crest of the parabolic drop. The design wall height is about 0.5 foot higher than that obtained by using the recommended freeboard for the minimum tailwater. The recommended freeboard is one-third of d_2. For tailwater depths higher than 719.0, the hydraulic jump will move upstream into the channel. The structural designers have indicated that the occurrence of the jump in the channel, with the resultant differential pressures, will not affect the structural design.

6. The location of the outlet structure was set to get a reasonable length of straight approach, to avoid the poor foundation soils downstream and to minimize the length of the concrete channel to reduce costs. It was also attempted to not put the structure too close to the main levee in order to reduce the potential for scour of the levee by creek flows and to increase the stability of the slopes from the top of levee to the bottom of the basin by providing a flat area between the levee and the structure.

7. The preformed scour hole downstream of the stilling basin is designed in accordance with plate C-43 of EM 1110-2-1602. Design data on the outlet structure follows shown on table A-1.

Table A-1

Chaska Creek Diversion Channel Outlet Structure

		Note
Design Discharge	6040 cfs	
Approach Flow Depth	6.56 ft	Normal depth for k = .0024'
Approach Flow Velocity	24.6 fps	
Approach Flow Froude No.	1.69	
Approach Channel Slope	.00604	
Parabolic Drop Eqn	$Y = -(0.00604x+0.02137x^2)$	From eqn 5-3 EM 1110-2-1602
Width	37.5 ft	
Elevation of Crest Drop	707.5	
Station of Crest of Drop	20+00	
Friction Loss-Parabolic Drop	0	Assumed
Basin Invert	696.5	Computed by trial & error to get a jump
Depth at Bottom of Drop, d_1	4.21 ft.	
V_1	38.3 fps	
Fr_1	3.3	
Conjugate Depth, d_2	17.6 ft.	
$.9d_2$	15.8	
Required Tailwater	712.3	$.9d_2$+Invert
Available Tailwater	712.3	
Velocity over End Sill	11.2 fps	
Riprap W_{50} Required Downstream	360 lbs	HDC 712-1 (high turbulence)
Top of Wall Elevation	719.0	
Chute Block Height	4.0 ft.	
Baffle Block Height	4.0 ft.	
End Sill Height	1.5 ft.	
Baffle & Chute Block Spacing	3.0 ft.	
	2.25 ft.	Next to wall
Length of Basin	50.0 ft.	
Distance to Baffle Blocks	17.0 ft.	

Reference: "The SAF Stilling Basin", Agriculture Handbook No. 156, U.S. Department of Agriculture, April 1959.

8. Channel. The proposed channel is designed to flow supercritical. The bottom slope of the channel, .00604, is steep enough to provide Froude numbers above 1.3 as recommended in EM 1110-2-1601 and thus minimize wave heights. The normal depth to critical depth ratio is .77, less than the maximum recommended in EM 1110-2-1601, 0.9, and the invert slope to critical slope ratio is 2.09. These values are based on the worst case maximum roughness, k = .0084 ft.

9. The minimum radius for bends was determined from equation 28 of EM 1110-2-1601.

$$r_{min} = \frac{4v^2w}{gy}$$

For all bends except the most upstream one, the flow was at normal depth and the minimum radius is about 390 feet. This was determined using velocities and depths using a minimum relative roughness k of .0024 foot. For the most upstream curve the flow would not have reached normal depth after coming down the ogee weir and the actual computed velocity and depth through the curve were used to get the minimum radius of 1160 feet. The invert of the channel is to be banked at bends. The amount of banking was set equal to twice the super-elevation computed by Equation 26 of EM 1110-2-1601.

$$y = C\,\frac{v^2w}{gr}$$

y = rise in water surface between theoretical level water surface at the center line and outside water surface elevation.

c = coefficient (see page 28 of EM 1110-2-1601), c = 0.5 since spiral transitions are to be used.

v = mean channel velocity.

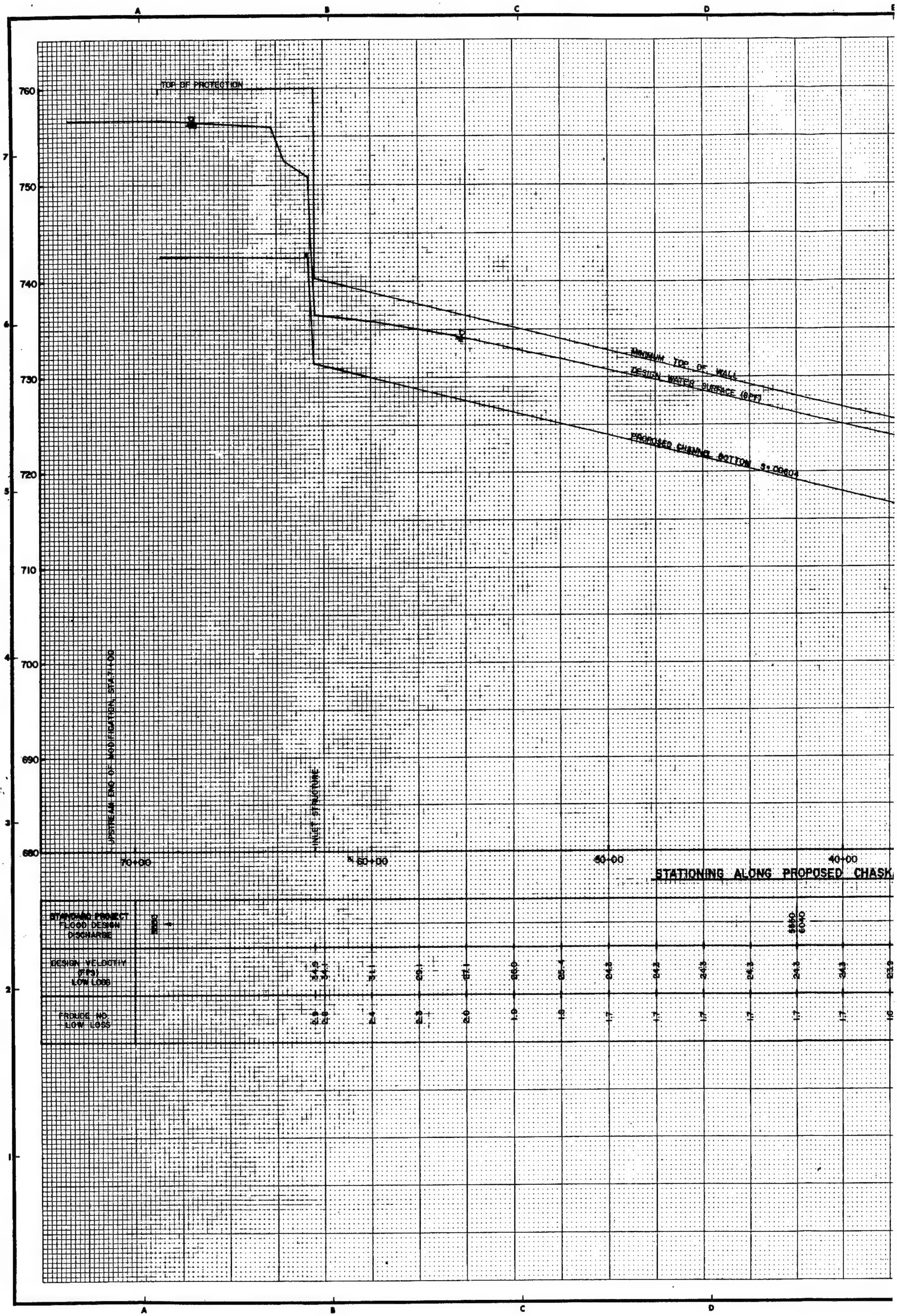
w = channel width at elevation of center-line water surface.

g = acceleration of gravity.

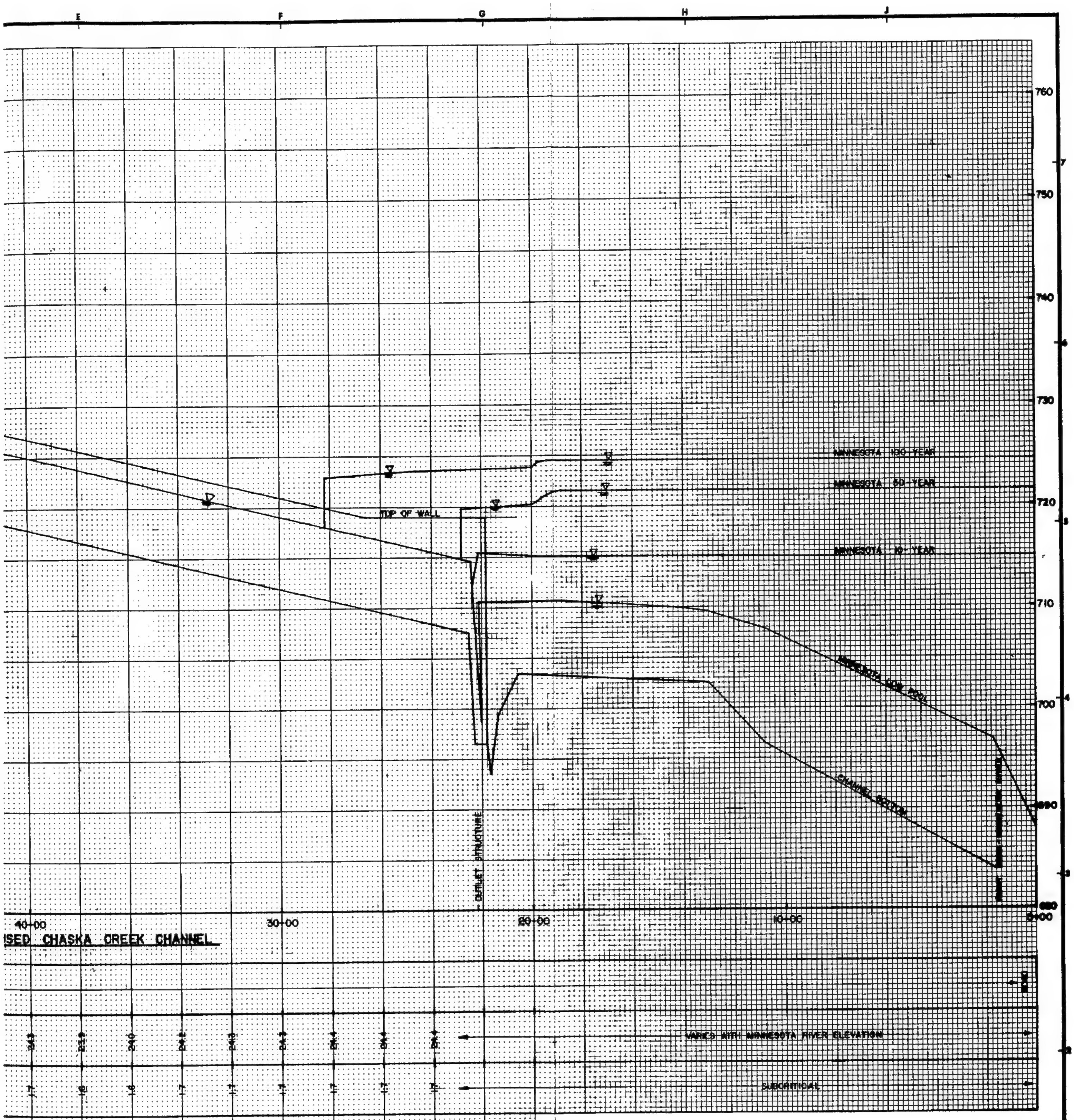
r = actual radius of channel center-line curvature.

The invert of the bottom is rotated about the channel invert grade on the inner side of the curve. The velocity used was computed using average loss coefficients in order to avoid being over or under banked.

10. Proposed radii of curves and banking are shown on plates 3-7. A table of required curve data follows:



TOP OF PROTECTION
MINIMUM TOP OF WALL
DESIGN WATER SURFACE (SPF)
PROPOSED CHANNEL BOTTOM
760
750
740
730
720
710
700
690
680
UPSTREAM END OF MODIFICATION, STA 71+00
INLET STRUCTURE
70+00
60+00
40+00
STATIONING ALONG PROPOSED CHASK
STANDARD PROJECT FLOOD DESIGN DISCHARGE
6040
DESIGN VELOCITY (FPS) LOW LOSS
34.1
26.0
25.4
24.3
FROUDE NO. LOW LOSS
2.0
1.9
1.8
1.7
1.6



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: P.M.F.
DRAWN BY: P.P.C.
CHECKED BY: P.M.F.
SUBMITTED BY:

FLOOD CONTROL FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
CHASKA WEST CREEK
WATER SURFACE PROFILES
PROPOSED CONDITIONS

APPROVED:
DATE: MARCH 1984
SCALE:
DRAWING NUMBER
M34-CH-9-5/110
SHEET OF

2

PLATE A-2

Table A-2

Curve Data

PI	Approx Station	Min Length Spiral (ft)	Min Radius (ft)	Actual Design Radius (ft)	Superelevation (ft)	Banking (ft)
3	28+72	27.3	420	390	.80	1.60
4	39+88	22.2	420	410	.74	1.48
5	50+69	21.0	390	410	.70	1.40
6	55+08	21.0	390	410	.70	1.40
7	59+66	15.3	1160	1160	.51	1.02

Minimum radii are based on low friction loss. Superelevation and banking are based on average losses and the actual design radii.

11. The channel bottom width changes from 35 feet to 37.5 feet at the ditch inlet at station 42+00. The design SPF discharge changes from 5550 cfs to 6040 cfs. The increased bottom width keeps the normal depth constant.

12. Since the channel is to flow supercritical with high velocities, it is important that the channel be constructed and maintained to have a fairly smooth alignment at the joints with no significant gaps. Because there is the potential for differential settlement, special treatment is needed at the joints. When possible differential settlement of over one inch is computed, the joint must be constructed to not allow the differential settlement. For joints where differentials are less than one inch, the joint must be constructed such that the downstream slab can only end up lower than the upstream slab.

13. Bridges. There are five bridges that cross the proposed channel: the First Street bridge, station 28+95; the Chicago and Northwestern Railroad bridge, station 29+85; the Hickory Street bridge, station 44+80; the Highway 212 bridge, station 56+10; and the Hillside Drive bridge, station 59+70. All bridges are to clear the SPF design water surface profile (high loss) by at least 2.0 feet, have no piers in the channel and not change the channel width. A table of required low chord elevation follows:

Table A-3

Bridge Data

Bridge	Station	Invert	Design* Water Surface	Banking (ft)	Min** Low Chord	Design Low Chord
First Street	28+95	711.4	718.6	1.82	722.4	723.4
C&NW RR	29+85	711.9	719.1	1.82	722.9	723.3
Hickory St.	44+80	720.9	728.1	-	730.1	731.0
Hwy 212	56+40	727.8	735.2	1.34	738.3	738.7
Hillside Drive	59+70	730.0	736.2	1.20	739.8	741.2

* Based on high loss coefficients
** Based on 2.0 ft. freeboard

14. Inlet Structure. The inlet structure is designed to return water surface profiles to existing conditions upstream of the channel modification, provide a smooth entrance into the supercritical channel and to lower the bottom elevation about 10 feet. The structure is shown on plates 6 and 21. The structure includes an ogee crest. The crest shape equations are from plates 24 and 25 of EM 1110-2-1603. The crest shape details are shown on plate A-2. The weir coefficient is from plate 32 of EM 1110-2-1603. ETL 1110-2-158, EM 1110-2-1601 and conversations with Mr. Bernie Johnson, LAD, were also used in the design and layout of the inlet structure. The ogee crest elevation was established to match existing conditions water surface profiles for various flood frequencies upstream of the project. The rating curves are shown on plate A-3. The structure is to be located just downstream of and tied into a natural restriction to help funnel the flow into the channel and prevent flanking.

15. Weep Holes. The geotechncial analysis and design for interception of groundwater flow requires the use of weep holes into the concrete channel. These are to be 4-inch diameter at 40-foot intervals and are to include flap gates to prevent backflow into the weep holes since the backflow could plug the drain material if the flow were heavily sediment laden. Because of the small size and long spacing of the holes, they are not expected to create any significant adverse turbulence to the channel flow.

16. Debris Barrier. The creek upstream of the project area contains leaning or fallen trees and large rocks. In order to keep the proposed supercritical flow channel clear during large flood events, a debris barrier is proposed at the upstream end of the channel modification as shown on plate 17. The structure was designed in accordance with "Debris Control Structures", Hydraulic Engineering Circular No. 9 by the Federal Highway Administration; EM 1110-2-1602 paragraph 3-5a, "Trash Struts"; and EM 1110-2-2400 paragraph 3-05, "Trash Structures." The two-foot high sill across the bottom and the cable one-foot above the side slopes are intended to stop boulders from entering the

concrete channel. The clear spacing of the vertical members, 6-feet, is equal to about 2/3 of the minumum dimension of the channel which is its height of 9.2 feet. Because of the barrier's large size, plugging should not raise the headwater significcantly. A 50 percent blockage was computed to only raise the headwater about 1.2 feet.

PRE-POST PROJECT CONDITIONS

17. Existing conditions water surface profiles and flooded outlines were not changed for Chaska Creek from those shown in the limited reevaluation report and outlines have not been replotted. Proposed conditions are to be protected from all floods up to the standard project flood, thus proposed conditions flooded outlines are also not plotted. Proposed conditions flood profiles are shown on plate A-4.

PROTECTIVE MEASURES

18. The Chaska Creek project is designed to eliminate damages from all floods up to the standard project flood. Exceedence of the design capacity during the project economic life has a 28 percent chance of occurring. This is based on a 100-year economic life and the SPF discharge of 5550 cfs having an exceedance probability of 0.33 percent (plate 4A-7 of the limited reevaluation report).

HYDRAULIC LOSSES

19. A sensitivity analysis was performed on the impact of the friction loss factors on stage, velocity and Froude Number. Because the proposed channel is prismatic, expansion and contraction losses are minor and no sensitivity analysis was performed on them. There are no bridge piers or constructions, therefore, there are no bridge losses. The Chezy equation was used for friction losses with the roughness values for the concrete channel from page 9 of EM 1110-2-1601. The k values shown in the EM for straight channels were increased 20 percent due to the bends. The results of the study are shown below for the design discharges of 5500 cfs from station 62+45 to 42+00 and 6040 cfs from stations 42+00 to 22+55.

Table A-4

Chaska Creek Sensitivity Analysis

	Low Loss	Med Loss	High Loss
Relative roughness k, (ft.)	.0024	.0054	.0084
Sta 62+45 to 42+00			
Normal depth, y_n (ft.)	6.5	6.9	7.2
Velocity at y_n (fps)	24.3	22.9	22.1
Froude No. at y_n	1.7	1.5	1.5
Equivalent Manning's "n"	.0135	.0147	.0155
Sta 42+00 to 22+55			
Normal depth, y_n	6.6	7.0	7.2
Velocity at y_n	24.4	23.2	22.4
Froude No. at y_n	1.7	1.6	1.5
Equivalent Manning's "n"	.0135	.0147	.0155

Bottom width Sta 62+45 to 42+00 = 35.0 ft.
Sta 42+00 to 22+55 = 37.5 ft.
Bottom slope = .00604

20. From the above table it is seen that the velocity, depth and Froude numbers are not very sensitive to the loss coefficients. This is expected for a prismatic concrete channel. A relative roughness k value of .125 ft. (Manning's n = .022) would be needed to have normal depth equal critical depth with the subsequent possibility of large waves. This 15 to 50 fold increase in k, from the design values of .0024 - .0084 foot, is very unlikely if the channel is properly maintained.

WATER SURFACE PROFILE STABILITY

21. The water surface profile for the Chaska Creek concrete rectangular channel is expected to be very stable. No degradation of the bottom is possible. The existing channel upstream is fairly stable (see pages 4B-15 and 4B-16 of the limited reevaluation report) and sediment aggradation should be minor. Because of the very high velocities in the concrete channel, any minor sediment left in the channel after maintenance should be swept away by the flow if vegetation is not allowed to become established.

22. Stability of the supercritical flow was checked for a range of flows from depths of 1.0 foot to the design depth, 6.6 feet. From plate 7 of EM 1110-2-1601, all flows with depths greater than 2.0 feet were stable. Flows with depths of 1.0 and 2.0 were on the line between stable and unstable. Any minor formation of slugs at these small depths would not adversely affect the project. A check by plate 45 of EM 1110-2-1601 indicates there will be no bulking of flow because the design Froude numbers are less than 1.7 for all flow conditions.

APPROACH AND EXIT CHANNELS

23. The exit channel from the outlet structure consists of a 837-foot long transition channel from the downstream end of the scour hole, station 21+37 to station 13+00. The bottom width transitions from 75 feet (twice the stilling basin width) at station 21+37 to existing width (about 20 feet) at station 13+00. At this point the flow should have returned to about the same state as for existing conditions with much of the flow in the overbank areas. Thus, the area from station 13+00 to the Minnesota River, station 0+00, should not be affected by the project.

24. The approach to the ogee crest inlet and concrete channel is a riprap trapezoidal channel with 1 horizontal on 3 vertical slopes, a 35 foot bottom width and an invert slope of 0.0005. This channel is about 660 feet long. This reach is through a natural restriction that funnels the flow into the proposed channel. Under natural conditions, this constriction tends to be a control for upstream flood profiles. By locating the proposed inlet control at the same location as an existing control, it was possible to get a good match of the existing conditions rating curve without going to an elaborate compound weir control structure. Therefore, upstream of station 69+00 the proposed conditions profiles for the full range of floods match the existing conditions profiles very well. See plate A-3. The proposed berm and road raise near the Highway 10 bridge upstream of the project is needed for adequate freeboard to prevent flood flows from going down the highway or its ditches and flanking the proposed channel inlet.

OPERATION AND MAINTENANCE

25. The principal maintenance item on Chaska Creek will be keeping the channel clear and in good repair. As stated in paragraph 21, sediment aggradation is expected to be minor. In the limited reevaluation report, page 4B-16, the total annual sediment removal cost for both Chaska and East Creeks was estiamted at $2000 (1982 dollars). Since the design flow is supercritical, major deterioration of the channel could result in a shift to subcritical flow and a large jump in water surface stage. Therefore, it will be especially important to provide good maintenance to Chaska Creek. It will also be very important that no obstructions be placed in the channel in the future, such as bridge piers.

FREEBOARD

26. The proposed channel design for Chaska Creek uses a minimum freeboard for the top of wall of 2.0 feet above the high loss water surface profile. The use of freeboard is necessary because of the high design velocities and potential project-induced erosion damages if the channel is overtopped. Since the water surface profile is highly stable (see paragraph 21) and since high loss coefficients were used, 2.0 feet of freeboard is considered adequate.

27. The recommended freeboard was checked against the criteria for supercritical chute spillways in EM 1110-2-1603. The freeboard obtained from the equation on page 76 of EM 1110-2-1603 is 3.1 feet versus the proposed 2.0 feet. The equation in EM 1110-2-1603 is to be used for chute spillways for reservoirs where the damages associated with failure are usually very high or catastrophic. As explained below, the risks are much lower for the Chaska Creek channel and the freeboard allowance can be reduced. The proposed 2.0 feet is considered reasonable.

28. Although the proposed concrete channel will cause the velocities of flood flows to increase to the point where they could cause large damage if they escaped the channel and entered a protected area, for this channel the risk of catastrophic damages is not significant due to the conservative design and due to the lack of areas adjacent to the channel that could sustain high damages. The proposed supercritical flow channel is designed for the standard project flood and has a simple rectangular form with no obstructions. No curves have radii less than the minimum recommended in EM 1110-2-1601 and all curves are to be banked and have spiral transitions. The conservative design of the bends should eliminate or reduce the cross-wave disturbance pattern, reference Chow's Open-Channel Hydraulics, article 16-7. Long straight sections are also proposed upstream of the inlet structure between the inlet and the most upstream curve, between curves that are in opposite directions (station 48+90 to 40+51) and at the downstream end between the last curve and the stilling basin. Because of this conservative design, the change of significant overtopping of the walls is small and because of the location of the channel anything less than major overtopping would not cause major or catastrophic damages. The channel is adjacent to the levee in only the lower portion and the levee is on the inside of the bend, reducing the chance for significant overtopping flow to attack it. Also, the levee is designed to protect against the Minnesota River 100-year flood and the likelihood of coincident large floods on both the creek and the river is very remote, so that any erosion of the levee by the creek would likely be repaired before it was threatened by the Minnesota River.

CARE OF WATER DURING CONSTRUCTION

29. The construction sequence proposed for Chaska Creek should not create any significant increase in the flooding hazard above existing conditions. A by-pass channel would be used at the lower end of the channel, the middle portion of the concrete channel is a diversion and would use the existing channel for conveying the creek flow, and the upper end of the channel would be constructed in such a way that large flood flows could be allowed to flow through the work area. For the upper end, there is no room to excavate a temporary by-pass channel around the project area and a pipe will likely be used for normal to small flood flows.

SIDE DRAINAGE

30. There will be two side drainage inlets, one from the right at about station 42+00 and outlet A from left near First Street, just below First Street. The drainage channel from the right (station 42+00) is designed for the standard project flood discharge of 690 cfs. The coincident discharge from the drainage at the peak creek SPF discharge is 490 cfs, raising the creek design discharge from 5550 to 6040 cfs. The proposed drainage channel at station 42+00 includes a concrete straight drop structure from the existing culverts, a 9-foot wide subcritical flow concrete channel and a side inlet into the creek channel. The 9-foot concrete channel will be covered for most of its length. The improvement of the drainage inlet at station 42+00 is required to insure the drainage enters the supercritical flow channel in such a manner that it does not create excessive turbulence.

31. Control Structure. The drainage channel starts at the two existing 60-inch RCP pipes under Highway 212. These pipes have about 9 feet of fill over their crowns to the road elevation and provide a positive entry into the proposed channel. A proposed drop structure is located at the outlet of two 60-inch pipes with a crest elevation of 738 (the pipe inverts), a stilling basin elevation of 720.5 and a downstream end sill elevation of 723.3. The length of the basin is 35 feet. The drop structure is shown on plate 23.

32. Channel. The concrete channel from the proposed drop structure is to have a 9-foot bottom width vertical side slopes and a bottom slope of .0035. The channel is designed to flow with a velocity less than or equal to 12 fps, this is needed to allow a sharp bend with a radius equal to about 3 times the width. The channel is to flow at a 6.4 foot depth for the design discharge of 690 cfs. For the covered portion, the freeboard is to be 3.2 feet to insure this portion does not pressurize. The beginning of the closed portion is not to start any closer than 50 feet from the drop structure in order to insure the inlet to the covered channel does not become submerged. The channel is large enough and is dry a large portion of the year so maintenance should not be a problem.

33. Side Channel Spillway Inlet. The channel empties into the proposed Chaska Creek diversion channel through a side channel spillway inlet. Reference plate 53 of EM 1110-2-1601. The spillway is 120 feet long and the spillway crest is set 0.5 feet above the high loss design water surface in the creek, thus the crest is 7.7 feet above the bottom. The head over the spillway is kept constant by converging the side channel width in the 120 feet. This insures the velocity and depth in the side channel remains constant. A 12-inch drain is provided at the low point of the side channel. The proposed Chaska Creek diversion channel bottom width will increase from 35 feet at the upstream end of the inlet to 37.5 feet at the downstream end. The side channel inlet is shown on plate 22.

34. Outlet A. the outlet A into the left side of the channel upstream of First Street, Station 29+00, is required for interior flood control and the design of this outlet is described in the interior flood control appendix. The outlet consists of a 60-inch diameter RCP entering the creek at a 30 degree angle. This angle was selected to be in conformance with EM 1110-2-1601, page 62, paragraph 18.h. There is a flap gate upstream of where the pipe outlets into the creek and this outlet should not be contributing when the creek discharge is high. The outlet is shown on plate 10.

INTERIOR FLOOD CONTROL

GENERAL

35. This section covers only section 1 and outlet A of the interior flood control plan for Chaska. No change has been made in the plans for outlet A following completion of the general design memorandum. The interior flood control plan for sections 2 through 4 and Courthouse Lake will be presented in a separate feature design memorandum.

EXISTING CONDITIONS

DESCRIPTION OF WATERSHED AND DRAINAGE PATTERNS

36. Section 1, as shown on plate A-5, consists of about 36 acres which contribute runoff to the existing Chaska Creek channel below the point of diversion and above the proposed levee. Runoff from this section currently flows overland generally to the southeast and northwest into the existing creek and then flows to the southwest in the creek. Chaska does not have a storm sewer system. Section 1 is relatively flat with elevations ranging from about 735 in the northeast to about 714 in the southwest. Land use in the area is predominantly residential. The area is almost completely developed so little or no future change in drainage patterns is foreseen.

PONDING AREA

37. Under proposed conditions, the existing Chaska Creek channel in section 1 will be designated as a ponding area. Elevation-area-storage curves for this section are shown on plate A-6.

DAMAGE-ELEVATION RELATIONSHIPS

38. For the purpose of defining flood damages resulting from interior runoff, an elevation-damage curve with a zero damage elevation of 718.5 was developed for section 1. The curve, shown on plate A-7, is based on July 1980 conditions and was updated to February 1981 price levels.

RIVER DISCHARGE AND STAGE DATA

39. Elevation-frequency curves for the Minnesota River at Chaska existing and future conditions are shown on plate 4A-4 of the "Limited Reevaluation Report for the Minnesota River at Chaska." An elevation-discharge rating curve for the Minnesota River at Chaska was developed from HEC-2 backwater profiles and is shown on plate A-8. The U.S. Geological Survey (USGS) has maintained a stream gaging station on the Minnesota River near either Carver or Jordan since 1934. The USGS gage was originally located near Carver, Minnesota, but in 1966 it was moved to its present location near Jordan, Minnesota, 9.8 miles upstream from Chaska. The drainage area of the Minnesota River is approximately 16,200 and 16,600 square miles near Jordan and Chaska, respectively. Since this is a relatively small increase in drainage area, the discharge-frequency relations at the Jordan gage were also used for Chaska. The discharge-duration relation for the Minnesota River at Chaska was combined with the elevation-discharge data at Chaska Creek (found on plate A-8) to develop the elevation-duration curve shown on plate A-9.

RAINFALL DATA

40. The 1/4-, 1/2-, 1-, 2-, 3-, 6-, 12-, 24-, 48-, and 96-hour duration rainfall depths for the 1-, 2.5-, 5-, 10-, 25-, 50-, and 100-year all-year theoretical rainfall events in the Chaska area were developed from National Weather Service (U.S. Weather Bureau) publications HYDRO 35 and TP-40 (references a and b)* and are presented in tables A-5 and A-6 and on plate A-10. The standard project storm, also shown in tables A-5 and A-6 and on plate A-10, was developed in accordance with criteria presented in EM 1110-2-1411 (reference c).

UNIT HYDROGRAPH

41. A unit hydrograph for the section 1 interior watershed, shown in Table A-8, was developed by using the Soil Conservation Service (SCS) unit hydrograph method in the HEC-1 computer program. Key parameters used in the computer program are shown in table A-7. Lag time (L) was computed using the following equation, found in SCS Technical Release (TR) No. 55 (reference d) as equation 3-2:

$$L = \frac{\ell^{0.8}(S+1)^{0.7}}{1900\ Y^{0.5}}$$

where: L = lag in hours

ℓ = hydraulic length of watershed in feet

$S = \frac{1000}{CN} - 10$ (CN is the SCS curve number)

Y = average watershed land slope in percent

*All references appear in the final section of this appendix.

A curve number for the watershed was obtained from table 2-2 in TR-55 and adjusted to high antecedent moisture conditions (AMC III).

RUNOFF HYDROGRAPHS

42. Runoff hydrographs for section 1 are presented in table A-9 and were generated using the HEC-1 computer program. Watershed characteristics necessary to generate the runoff hydrographs from the SCS unit hydrograph, including the SCS curve number and ratio of imperviousness, are shown in table A-7. The rainfall distributions used are from table A-6.

SEEPAGE

43. Seepage in section 1 is considered to be insignificant and is further discussed in the "Seepage and Uplift" paragraph of the Geotechnical Appendix.

RECOMMENDED PLAN

GENERAL

44. For section 1, the recommended interior flood control plan will consist of a gated gravity outlet and a designated ponding area. A plan view showing the location of the proposed interior flood control features is presented on plate A-5. A plan and profile of outlet A is shown on plate 11 of the main report. The required facilities are further defined in the following paragraphs.

GRAVITY OUTLET

45. Outlet A is a 60-inch RCP located through the proposed levee where it crosses the existing Chaska Creek channel. The outlet has a gatewell with sluice gate and another gatewell with flap gate located at the riverward toe of the levee. From there, the outlet continues on between the proposed levee and railroad tracks before discharging into the proposed Chaska Creek channel. Table A-10 presents the required size, length, invert elevation and other design information for the proposed gravity outlet.

DESIGNATED PONDING AREA

46. The designated ponding area is defined in paragraph 37 and shown on plate A-5.

PLAN OF OPERATION

47. During low river gravity flow conditions, the sluice gate at outlet A will be open. Runoff from section 1 will flow into the portion of Chaska Creek below the diversion, flow down the creek bed and finally discharge through outlet A into the Chaska Creek diversion

channel. During flood periods, the runoff from section 1 will pond adjacent to outlet A. It will not be necessary to close the sluice gate unless the flap gate fails.

48. Should the interior water level (pond level) rise 1 foot or more above the current river stage, the sluice gate, if closed, will be temporarily opened. When the interior pond level recedes to the same level as in the river, the gate will be closed again.

PROJECT JUSTIFICATION

PERFORMANCE OF PROPOSED STORMWATER SEWERAGE SYSTEM

49. Table A-11 presents the maximum interior pond levels and resulting damages which would have occurred with the proposed interior flood control facilities during a 2-, 1-percent and standard project theoretical storms. The maximum pond elevations were obtained by routing the selected rainfall events through the selected ponding area and gravity outlet. Estimated damages are based on the maximum pond elevations and were obtained from the elevation-damage curve shown on plate A-7. The estimated interior pond levels for the 1-percent and standard project storm gravity flow conditions are outlined on plate A-11.

JUSTIFICATION OF GRAVITY DESIGN

50. As indicated in table A-11, the gravity outlet is more than adequate to maintain a 1-percent pond level less than or equal to the zero damage elevation. For the standard project storm, damages would occur in section 1. The 1-percent and standard project storm pond levels are outlined on plate A-11.

SELECTION OF GATE CLOSURE ELEVATIONS

51. A gate closure elevation of 713.5 was selected for section 1 because closure at a higher elevation would reduce the volume of storage available below the zero damage elevation of 718.5.

ELEVATION-FREQUENCY INFORMATION

52. Elevation-frequency information for section 1 is available directly from the probabilistic-economic analysis that was performed and is shown in table A-13 and on plate A-14. The 1-percent pond level is 718.4 for section 1.

DESIGN CRITERIA

DESIGN OF GRAVITY OUTLET

53. The design of the gravity outlet for the non-flood gravity discharge condition is initially based on inflow from a 2-percent event; however, the required size is subsequently modified, if necessary, to limit interior flood damages from the 1-percent and standard project storms to an acceptable level. The proposed location of the gravity outlet is shown on plate A-5, defined in paragraph 45 and in table A-10. Outlet A discharges into the Chaska Creek diversion channel. The outlet will be equipped with a gatewell and sluice gate plus an additional gatewell with a flap gate at the riverward toe of the levee. Discharge rating curves for the gravity outlet are shown on plate A-12. The design of the gravity oulet is based on the criteria presented in TM 5-820-4 (reference e) and on the peak inflow from a 2-percent storm. The gravity outlet is to be reinforced concrete pipe. Manning's roughness coefficient is assumed to be 0.013 and the entrance loss coefficient is assumed to be 0.5 for the gravity outlet.

PROBABILISTIC ANALYSIS

54. A probabilistic rainfall-streamflow analysis was performed for section 1. The analysis assumed the gravity oulet will be reopened when the interior pond level exceeds the selected river stage by 1 foot. Even though outlet A will be equipped with a flap gate and the sluice gate may not be closed, the assumption was used for section 1. At the selectd gate closure elevation of 713.5 in section 1, the flow in the river is about 43,000 cfs, which has an exceedence frequency of about 12 percent and a duration of about 0.5 percent of the time.

55. The initial step in performing the probabilistic rainfall-streamflow analysis is to prepare a stage-duration curve for the Minnesota River as shown on plate A-9, subdivide the area beneath the curve into an appropriate number of sections and obtain the average river stage for each section. As shown on plate A-9, the area beneath the curve was divided into six sections representing incremental durations of 0.94, 4.22, 7.34, 15.7, 21.8 and 50 percent. The average stages on the Minnesota River at Chaska Creek (plate A-9) for each of the six incremental durations are 715.3, 706.9, 703.0, 698.5, 693.8 and 688.8, respectively.

56. Maximum pond levels presented in table A-12 are based on the combination of the above river stages and all-year rainfall events having a frequency of occurrence of about 100-, 40-, 20-, 10-, 4-, 2- and 1-percent. An elevation-storage curve for the Chaska Creek ponding area in section 1 is shown on plate A-6. Theoretical runoff hydrographs for the above all-year rainfall events are presented in table A-9 for section 1. Elevation-discharge curves for the proposed 60-inch RCP outlet for section 1 are shown on plate A-8.

57. Pond level-frequency relationships based on the selected river stages, no pumping condition, and rainfall events investigated are presented on plate A-13. The curves were obtained by plotting the maximum pond levels versus the rainfall frequencies from table A-12.

58. The combined pond level exceedence probabilities for various interior pond levels based on the six selected river stages, seven rainfall events and the no-pumping condition are shown in table A-13. The frequency of occurrence for the various pond levels were obtained by multiplying the frequencies from plate A-13 times the selected river stage duration and totaling these values for each of the six selected river stages. The values were then multiplied by 100 to obtain the percent chance of occurrence. The damages shown in table A-13 were obtained from the damage-elevation curve on plate A-7 and represent damages at the selected pond levels. An elevation-frequency curve for section 1 is shown on plate A-14.

59. As shown in table A-13 and on plate A-14, no damages would occur in section 1 for the 1-percent event; therefore, no damage-frequency curves were developed for this section. In addition, as no damages occur for the 1-percent event, no pumping station is recommended.

DEPENDENT RAINFALL ANALYSIS

60. In addition to the probabilistic analysis, a dependent rainfall analysis was performed. In this analysis, it was assumed that rainfall occurred simultaneously over the Chaska Creek watershed and the section 1 interior watershed. As described in Appendix 4A of the Phase I General Design Memorandum (GDM) for the Minnesota River at Chaska, an HEC-1 computer model was developed to perform flood routings for Chaska Creek. Thirty-minute unit hydrographs were develoepd from 5-minute unit hydrographs using S-curve techniques. A time interval of 30-minutes was then used as the computational interval. A similar procedure was used to convert the 5-minute unit hydrograph for the section 1 interior watershed to a 30-minute unit hydrograph. The 1-percent (100-year) point rainfall pattern from the Chaska Creek computer model was applied to the 30-minute unit hydrograph using the HEC-1 computer model to get a 1-percent runoff hydrograph. Other key parameters used in the computer model are shown in Table A-7. This runoff hydrograph was routed through the Chaska Creek ponding area and then the pond elevations were compared to water surface elevations in the Chaska Creek supercritical channel. Water surface elevations were obtained using the 100-year (1-percent) future conditions flood hydrograph for Chaska Creek, shown on plate 4A-16 of the Phase I GDM, and a normal depth rating curve developed for the supercritical channel. If the water surface elevation in the channel was high enough to limit outflow from the gravity outlet, the routing was adjusted using the head-discharge curve shown on plate A-12. Although the water surface elevations in the channel did control outflow for a short time, it did not cause a maximum pond elevation higher than the 1-percent gravity flow elevation of 718.4 shown in table A-11. Dependent rainfall

routings were not done for more frequent events since the 1-percent event did not cause higher pond elevations. In addition, the recommended plan was not modified for the same reason.

REFERENCES

a. National Weather Service HYDRO-35, "Five- to 60-Minute Precipitation Frequency for the Eastern and Central United States, June 1977.

b. National Weather Service Technical Report No. 40, "Rainfall Frequency Atlas of the United States," May 1961.

c. EM 1110-2-1411, Standard Project Flood Determinations (Civil Works Engineer Bulletin No. 52-8, March 1952).

d. Soil Conservation Service Technical Release No. 55, "Urban Hydrology for Small Watersheds," January 1975.

e. TM 5-820-4, Drainage for Areas other than Airfields.

The following references, although not specifically referred to, were also used in the development of the interior flood control plan:

f. "Water Resources Data for Minnesota," U.S. Department of the Interior, Geological Survey.

g. EM 1110-2-1601, Hydraulic Design of Flood Control Channels.

h. EM-1110-2-1602, Hydraulic Design of Reservoir Outlet Works.

i. "Hydraulic Charts for the Selection of Highway Culverts," Hydraulic Engineering Circular No. 5, U.S. Department of Transportation, Federal Highway Administration, April 1977.

Table A-5

Accumulated 96-hour Theoretical Rainfall Amounts
and Hourly Incremental Rainfall Amounts

Rainfall duration in Hours	Accumulated 96-hour theoretical rainfall amounts							
	Rainfall Frequency in Percent							
	100	40	20	10	4	2	1	SPS
1/2	0.90	1.23	1.44	1.67	1.89	2.16	2.50	2.90
1	1.14	1.51	1.75	2.06	2.32	2.63	3.00	3.66
1 1/2	1.25	1.68	1.94	2.29	2.58	2.95	3.27	4.38
2	1.33	1.81	2.09	2.47	2.79	3.16	3.53	5.10
2 1/2	1.40	1.90	2.21	2.59	2.94	3.32	3.72	5.80
3	1.46	1.98	2.30	2.71	3.06	3.47	3.88	6.44
3 1/2	1.51	2.05	2.38	2.81	3.18	3.59	3.99	7.02
4	1.55	2.11	2.43	2.89	3.28	3.69	4.09	7.59
4 1/2	1.59	2.17	2.49	2.96	3.37	3.79	4.18	8.14
5	1.63	2.23	2.55	3.02	3.45	3.87	4.26	8.64
5 1/2	1.67	2.28	2.60	3.08	3.51	3.94	4.34	9.12
6	1.69	2.33	2.65	3.14	3.57	4.01	4.41	9.60
12	1.85	2.60	3.00	3.50	4.10	4.60	5.10	10.91
18	2.00	2.85	3.30	3.80	4.50	5.10	5.60	11.71
24	2.15	2.95	3.50	4.00	4.75	5.40	5.95	12.10
48	2.60	3.50	4.10	4.60	5.60	6.40	7.00	13.50
72	2.85	3.80	4.50	5.10	6.15	7.00	7.65	14.10
96	3.15	4.15	4.85	5.55	6.60	7.45	8.20	14.30

Rainfall distribution in Hours (1)	Hourly Incremental Rainfall Amounts							
1	0.06	0.10	0.10	0.12	0.12	0.14	0.15	0.10
2	0.08	0.12	0.12	0.13	0.17	0.18	0.24	0.10
3	0.09	0.13	0.13	0.18	0.22	0.22	0.32	0.16
4	0.13	0.17	0.21	0.24	0.27	0.31	0.35	0.20
5	0.19	0.30	0.34	0.41	0.47	0.53	0.53	0.23
6	1.14	1.51	1.75	2.06	2.32	2.63	3.00	0.52
7								0.96
8								1.05
9								1.15
10								1.34
11								1.44
12								3.66

(1) Rainfall amounts for the standard project storm are for a maximum 12-hour period rainfall. For other events, rainfall amounts are for a maximum 6-hour period rainfall.

Table A-6

Incremental Rainfall Amounts

Rainfall Distribution Hr.	Min.	Rainfall Frequency in Percent 100	40	20	10	4	2	1	SPS	Rainfall Distribution Hr.	Min.	SPS Cont.
0	05	-	-	-	0.01	0.01	0.01	0.01	-	6	05	0.08
0	10	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	6	10	0.08
0	15	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	6	15	0.08
0	20	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	6	20	0.08
0	25	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	6	25	0.08
0	30	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	6	30	0.08
0	35	-	-	-	0.01	0.01	0.01	0.01	-	6	35	0.08
0	40	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	6	40	0.08
0	45	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	6	45	0.08
0	50	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	6	50	0.08
0	55	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	6	55	0.08
1	00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	7	00	0.08
1	05	-	0.01	0.01	0.01	0.01	0.01	0.01	-	7	05	0.09
1	10	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	7	10	0.09
1	15	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	7	15	0.09
1	20	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	7	20	0.10
1	25	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	7	25	0.10
1	30	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	7	30	0.10
1	35	-	0.01	-	0.01	0.01	0.01	0.01	-	7	35	0.09
1	40	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	7	40	0.09
1	45	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	7	45	0.10
1	50	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	7	50	0.10
1	55	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	7	55	0.10
2	00	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01	8	00	0.10
2	05	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	8	05	0.12
2	10	-	0.01	0.01	0.01	0.01	0.01	0.02	0.01	8	10	0.12
2	15	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	8	15	0.12
2	20	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	8	20	0.12
2	25	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01	8	25	0.12
2	30	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01	8	30	0.12
2	35	-	0.01	0.01	0.01	0.02	0.02	0.02	0.01	8	35	0.12
2	40	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	8	40	0.12
2	45	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	8	45	0.12
2	50	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	8	50	0.12
2	55	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	8	55	0.12

Table A-6 (Cont.)

Rainfall Distribution Hr.	Min.	Rainfall Frequency in Percent 100	40	20	10	4	2	1	SPS	Rainfall Distribution Hr.	Min.	SPS Cont.
3	00	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.02	9	00	0.12
3	05	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01	9	05	0.12
3	10	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01	9	10	0.12
3	15	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.02	9	15	0.12
3	20	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.02	9	20	0.12
3	25	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.02	9	25	0.13
3	30	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.02	9	30	0.13
3	35	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.01	9	35	0.30
3	40	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.01	9	40	0.30
3	45	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.02	9	45	0.30
3	50	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.02	9	50	0.40
3	55	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.02	9	55	0.50
4	00	0.02	0.02	0.02	0.02	0.03	0.03	0.04	0.02	10	00	1.10
4	05	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.01	10	05	0.12
4	10	0.01	0.02	0.02	0.03	0.03	0.03	0.04	0.01	10	10	0.12
4	15	0.01	0.02	0.02	0.03	0.03	0.03	0.04	0.02	10	15	0.12
4	20	0.01	0.02	0.03	0.03	0.04	0.04	0.04	0.02	10	20	0.12
4	25	0.02	0.02	0.03	0.03	0.04	0.04	0.04	0.02	10	25	0.11
4	30	0.02	0.03	0.03	0.03	0.04	0.04	0.04	0.02	10	30	0.11
4	35	0.01	0.02	0.03	0.03	0.03	0.05	0.04	0.02	10	35	0.11
4	40	0.02	0.03	0.03	0.04	0.04	0.05	0.04	0.02	10	40	0.11
4	45	0.02	0.03	0.03	0.04	0.04	0.05	0.04	0.02	10	45	0.11
4	50	0.02	0.03	0.03	0.04	0.05	0.05	0.05	0.02	10	50	0.11
4	55	0.02	0.03	0.03	0.04	0.05	0.06	0.05	0.02	10	55	0.10
5	00	0.02	0.03	0.04	0.04	0.05	0.06	0.05	0.03	11	00	0.10
5	05	0.04	0.04	0.04	0.06	0.06	0.07	0.08	0.03	11	05	0.10
5	10	0.04	0.04	0.04	0.06	0.06	0.10	0.08	0.03	11	10	0.09
5	15	0.04	0.05	0.05	0.06	0.07	0.10	0.08	0.04	11	15	0.09
5	20	0.04	0.05	0.06	0.07	0.08	0.10	0.08	0.04	11	20	0.09
5	25	0.04	0.05	0.06	0.08	0.08	0.10	0.08	0.04	11	25	0.09
5	30	0.04	0.05	0.06	0.08	0.08	0.10	0.10	0.04	11	30	0.09
5	35	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.05	11	35	0.09
5	40	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.05	11	40	0.09
5	45	0.10	0.10	0.15	0.20	0.20	0.30	0.30	0.05	11	45	0.09
5	50	0.10	0.20	0.25	0.30	0.30	0.40	0.40	0.05	11	50	0.09
5	55	0.20	0.30	0.30	0.40	0.50	0.50	0.70	0.05	11	55	0.09
6	00	0.30	0.43	0.54	0.57	0.69	0.76	0.90	0.05	12	00	0.09

Table A-7

Interior Watershed Characteristics

Section	Subsection	Area (mi^2)	Area (acres)	Slope (ft/ft)	Watershed length(ft)	Lag time L(1)	Ratio impervious	SCS curve number CN(2)
1		0.06	36	0.017	2,200	0.34	0.30	93

(1) See paragraph 41 for definition.
(2) Antecedent moisture condition (AMC) III.

Table A-8

5-Minute Unit Hydrograph for
the Section 1 Interior Watershed

Time HR MIN	1
0:05	8
0:10	25
0:15	50
0:20	65
0:25	67
0:30	57
0:35	43
0:40	29
0:45	20
0:50	14
0:55	10
1:00	7
1:05	5
1:10	3
1:15	2
1:20	2
1:25	1
1:30	1
1:35	1
1:40	0

Table A-9

Runoff Hydrographs for Section 1

Time in Hours	Rainfall Frequency in Percent							
	100	40	20	10	4	2	1	SPS
0	0	0	0	0	0	0	0	0
0.5	0	0	0	0	0	0	0	0
1.0	0	0	0	0	0	0	0	0
1.5	0	0	0	0	2	3	3	0
2.0	0	0	0	1	3	4	4	0
2.5	0	0	1	1	4	4	4	0
3.0	0	0	1	4	4	4	5	2
3.5	0	1	4	4	4	6	8	3
4.0	1	4	4	4	8	8	8	4
4.5	4	4	5	8	8	8	9	4
5.0	5	5	9	10	11	11	14	6
5.5	6	10	16	23	29	33	38	8
6.0	32	49	74	92	114	130	145	13
6.5	9	13	20	23	28	33	37	16
7.0	4	4	4	6	7	8	8	18
7.5	0	0	0	0	0	2	3	22
8.0						0	0	25
8.5								36
9.0								50
9.5								87
10.5								177
11.0								98
11.5								55
12.0								39
12.5								28
13.0								11
13.5								1
14.0								0

Table A-10

Design of Gravity Outlet

Outlet Identification	A
Location	Section 1
Pipe Diameter (In.)	60
Number of Piper Required	1
Design Discharge, cfs	94
Slope Ft/Ft	0.0013
Upstream Invert Elevation	713.5
Approximate Length, Ft.	760
Maximum Design Water Surface Elevation	718.0
Maximum Allowable Water Surface Elevation	718.5
Inlet Control	
Type of Gate(s) Required	Sluice

NOTE: Outlet A is to be reinforced concrete pipe. An entrance loss coefficient of 0.5 and a Manning's "n" of 0.013 were assumed.

Table A-11

Maximum Pond Levels During Theoretical Rainfall Events
With Recommended Interior Flood Control Plan (Gravity Flow)

Area	2-percent Elevation	Damages in Dollars	1-percent Elevation	Damages in Dollars	SPS Elevation	Damages in Dollars
Section 1	718.0	-	718.4	-	719.7	38,000

Table A-12

Maximum Interior Pond Levels Produced by All-Year Events
(Assuming gates reopened at 1.0 foot head)

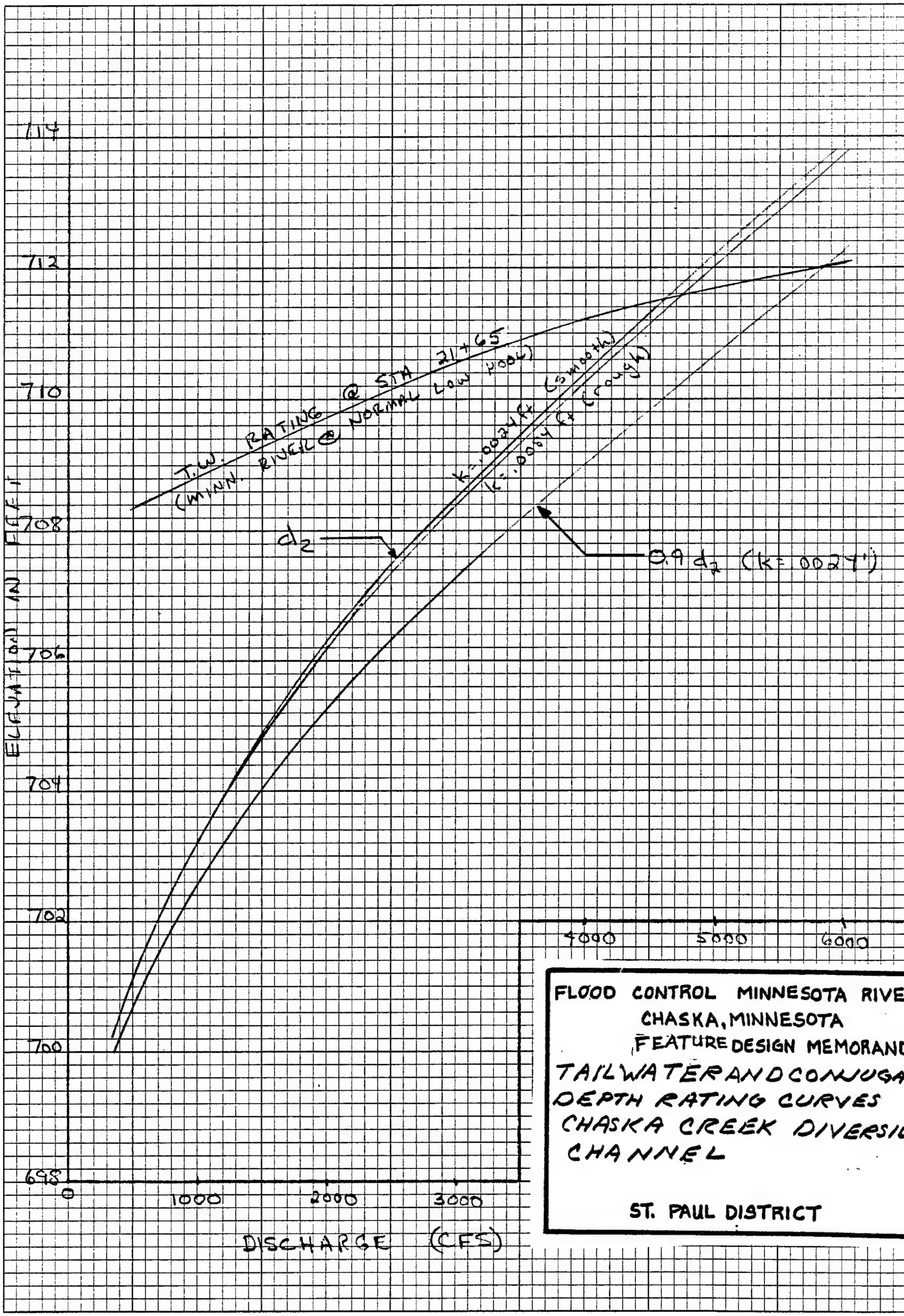
River Stage	Rainfall Frequency in Percent 100	40	20	10	4	2	1
Section 1, Chaska Creek Ponding Area - No Pumping							
688.8	715.3	715.9	716.6	717.1	717.7	718.0	718.4
693.8	715.3	715.9	716.6	717.1	717.7	718.0	718.4
698.5	715.3	715.9	716.6	717.1	717.7	718.0	718.4
703.0	715.3	715.9	716.6	717.1	717.7	718.0	718.4
706.9	715.3	715.9	716.6	717.1	717.7	718.0	718.4
715.3	716.3	716.3	716.6	717.1	717.7	718.0	718.4

Table A-13

Water Level Exceedence Probabilities

Section 1, Chaska Creek Ponding Area - No Pumping

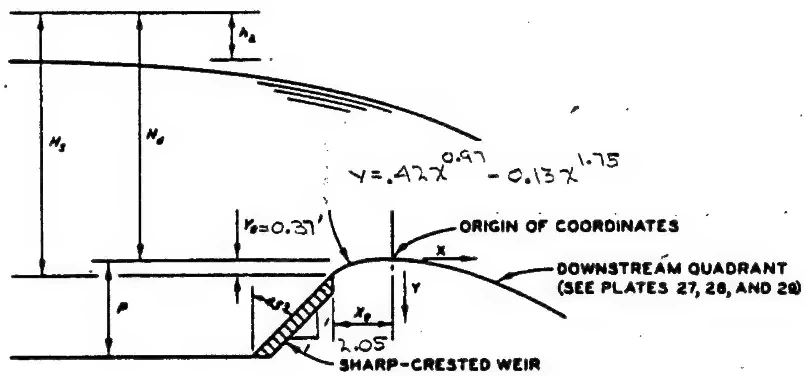
Index River Stages	688.8	693.8	698.5	703.0	706.9	715.3	Chance of Exceedence in Events Per Year	Return Period of Events in Years	Damages in Dollars
Duration	0.50	0.218	0.157	0.0734	0.0422	0.0094			
Pond Level									
715.0	1	1	1	1	1	1	1	1.0	0
715.5	0.880	0.880	0.880	0.880	0.880	1	0.881	1.1	0
716.0	0.368	0.368	0.368	0.368	0.368	1	0.374	2.7	0
716.5	0.236	0.236	0.236	0.236	0.236	0.236	0.236	4.2	0
717.0	0.114	0.114	0.114	0.114	0.114	0.114	0.114	8.8	0
717.5	0.048	0.048	0.048	0.048	0.048	0.048	0.048	20.8	0
718.0	0.020	0.020	0.020	0.020	0.020	0.020	0.020	50.0	0
718.5	0.0084	0.0084	0.0084	0.0084	0.0084	0.0084	0.0084	119.0	0
719.0	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	400	18,000



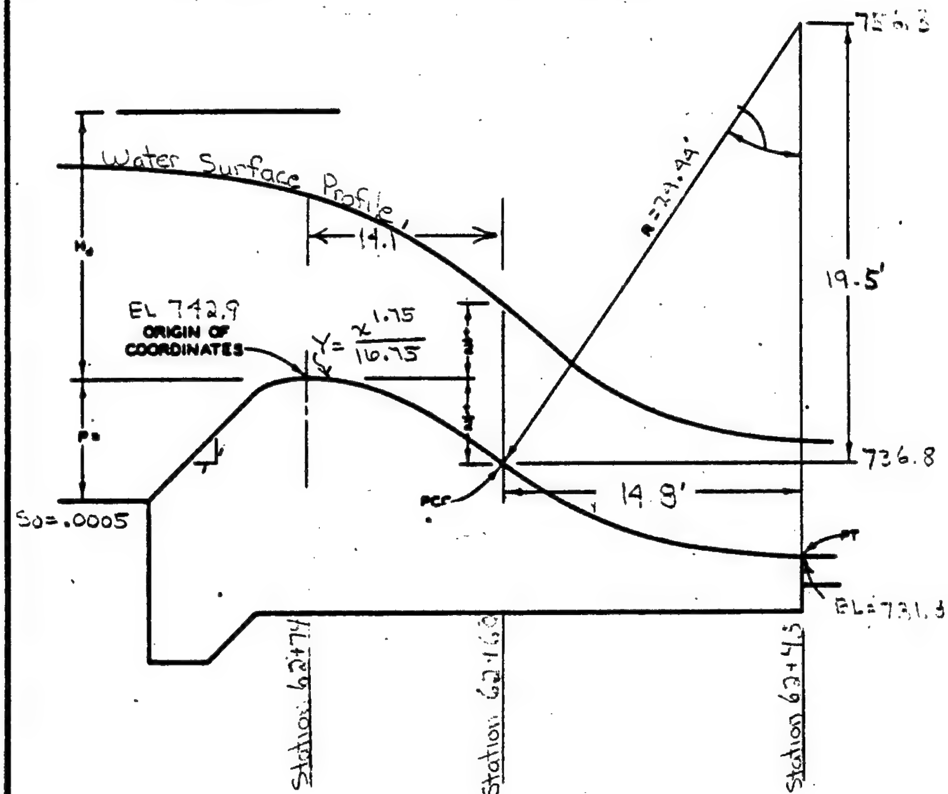
FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
FEATURE DESIGN MEMORANDUM
TAILWATER AND CONJUGATE DEPTH RATING CURVES
CHASKA CREEK DIVERSION CHANNEL

ST. PAUL DISTRICT

PLATE A-1



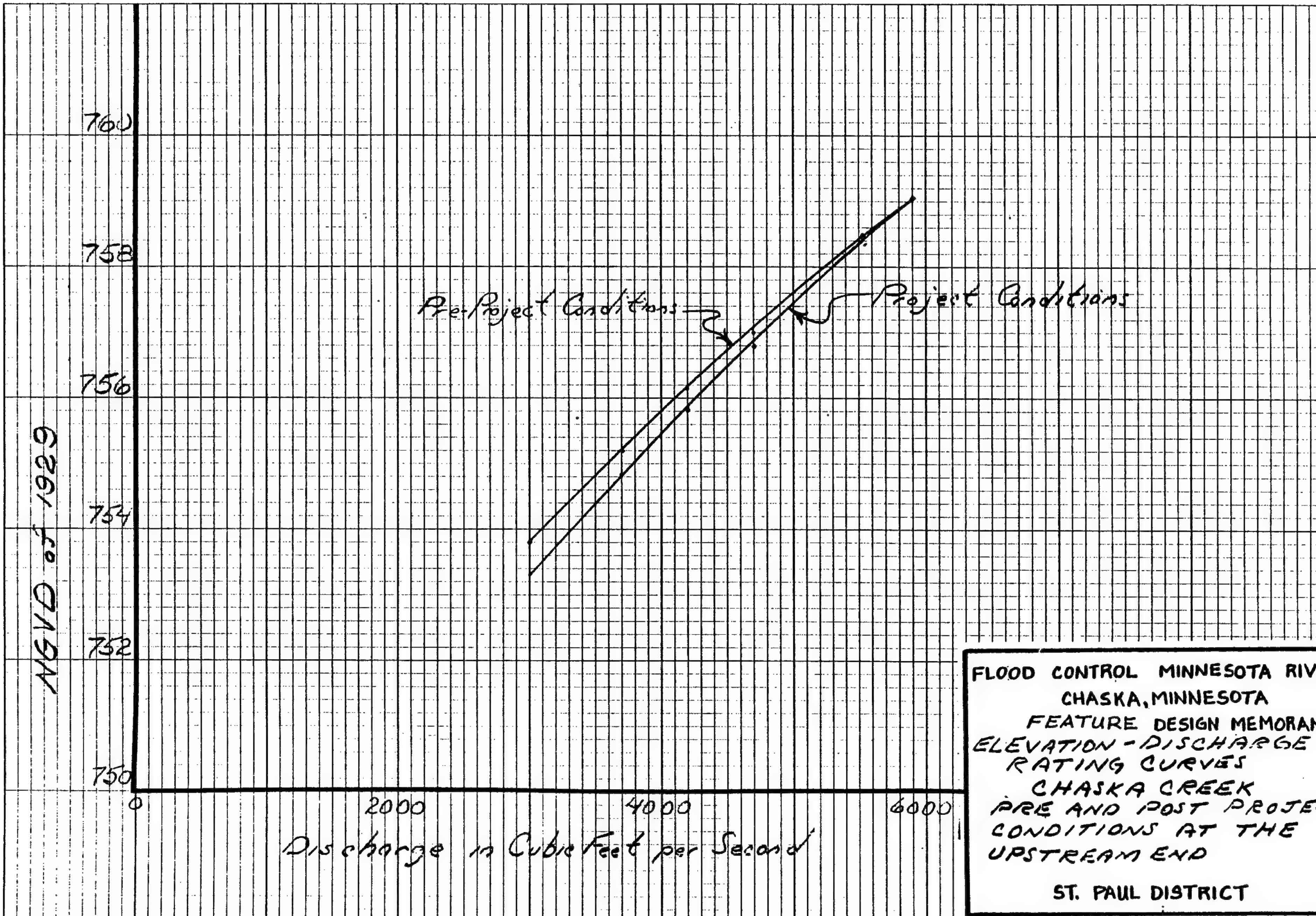
LOW OGEE CRESTS
UPSTREAM QUADRANT COORDINATES



LOW OGEE CRESTS
GEOMETRY

FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
FEATURE DESIGN MEMORANDUM
OGEE SPILLWAY
HYDRAULIC DATA
CHASKA CREEK

ST. PAUL DISTRICT



FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
FEATURE DESIGN MEMORANDUM
ELEVATION - DISCHARGE
RATING CURVES
CHASKA CREEK
PRE AND POST PROJECT
CONDITIONS AT THE
UPSTREAM END

ST. PAUL DISTRICT

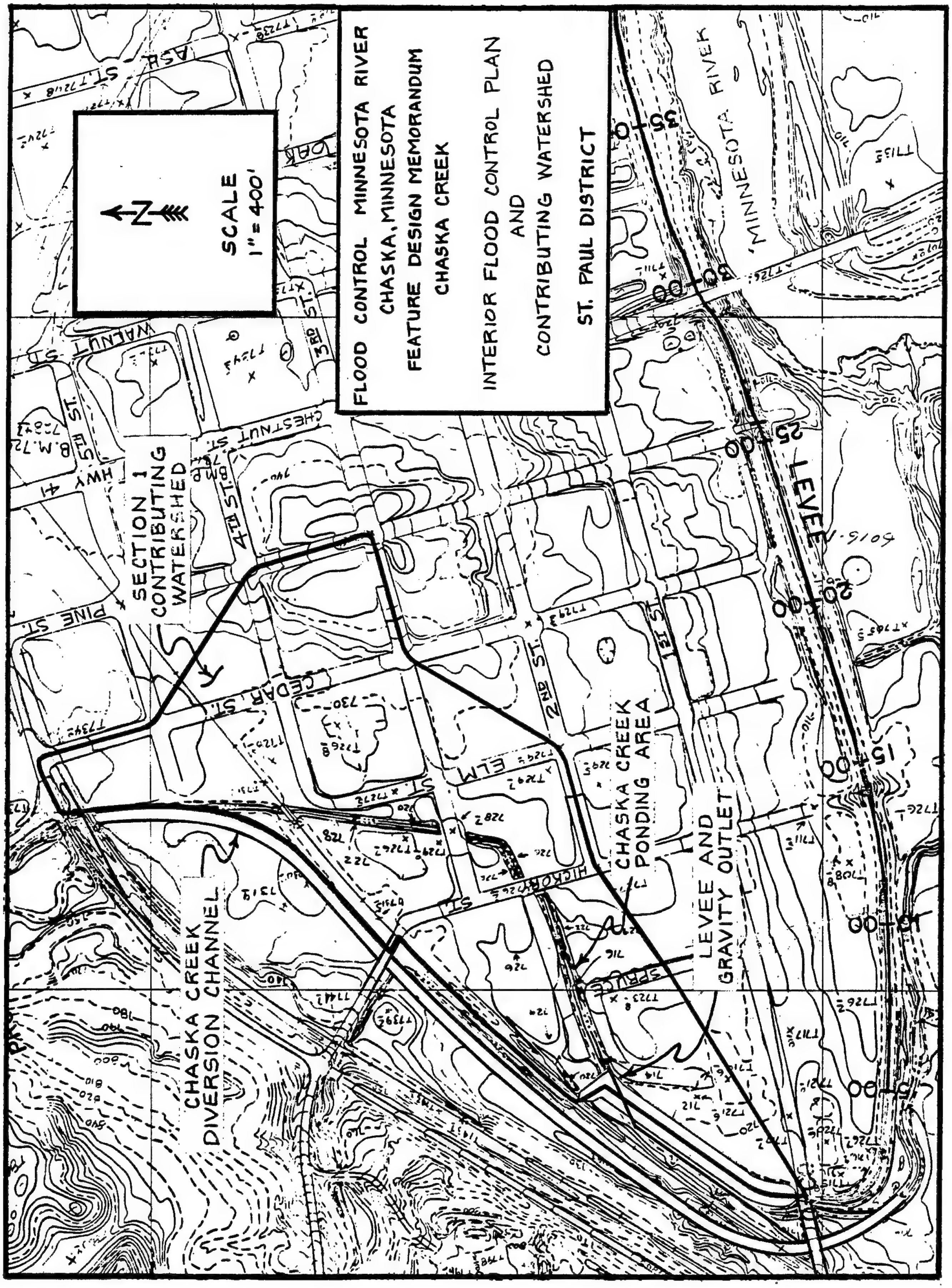
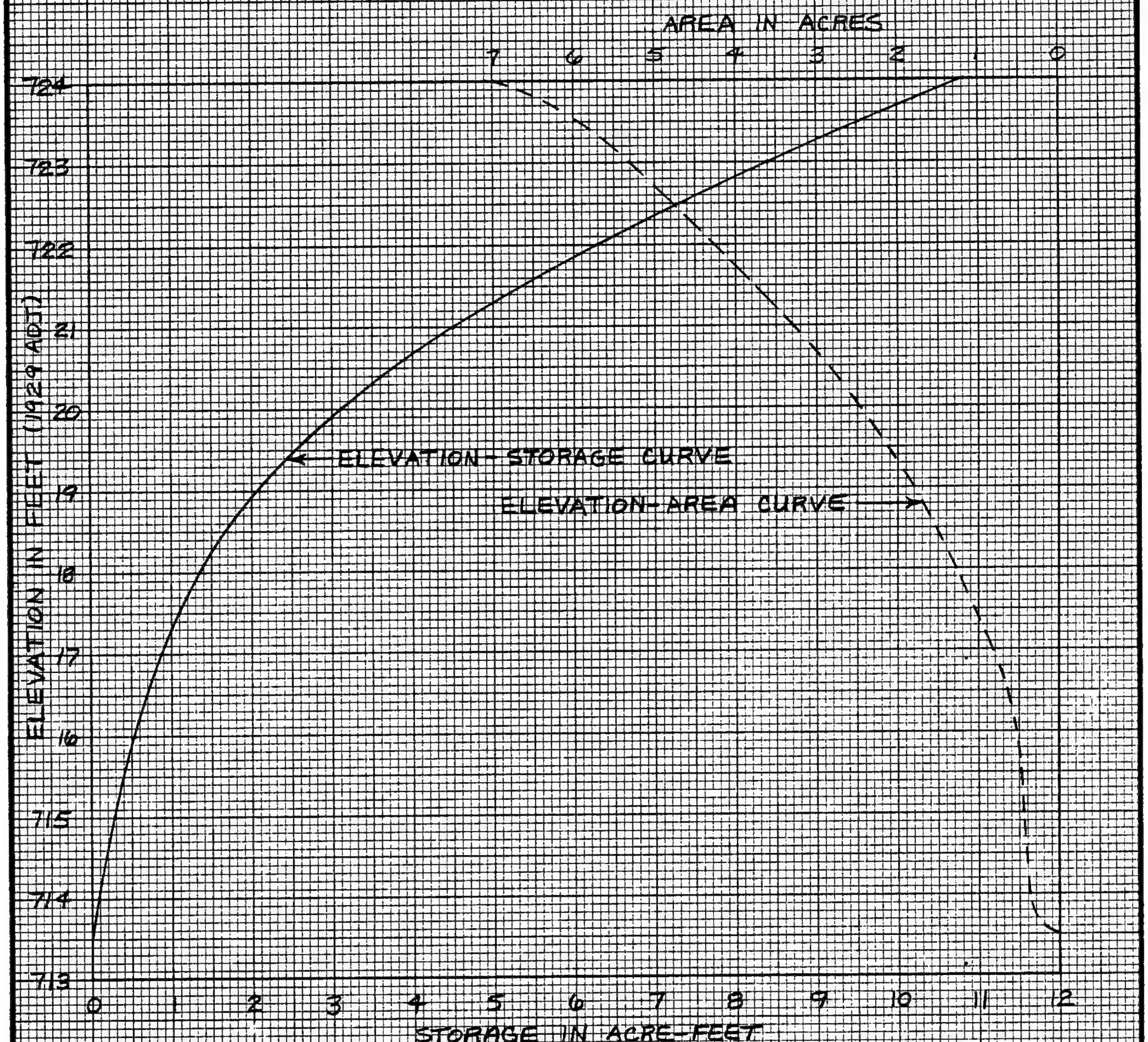

FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
FEATURE DESIGN MEMORANDUM
CHASKA CREEK
INTERIOR FLOOD CONTROL PLAN
AND
CONTRIBUTING WATERSHED
ST. PAUL DISTRICT
SCALE
1" = 400'
N
SECTION 1
CONTRIBUTING
WATERSHED
CHASKA CREEK
PONDING AREA
LEVEE AND
GRAVITY OUTLET
CHASKA CREEK
DIVERSION CHANNEL
LEVEE
MINNESOTA RIVER
PINE ST.
CEDAR ST.
CHESTNUT ST.
WALNUT ST.
ASH ST.
ELM
HICKORY
SPRUCE
4TH ST.
2ND ST.
1ST ST.
3RD ST.
5TH ST.
HWY 41
OAK
B.M.
35+00
30+00
25+00
20+00
15+00
10+00
5+00

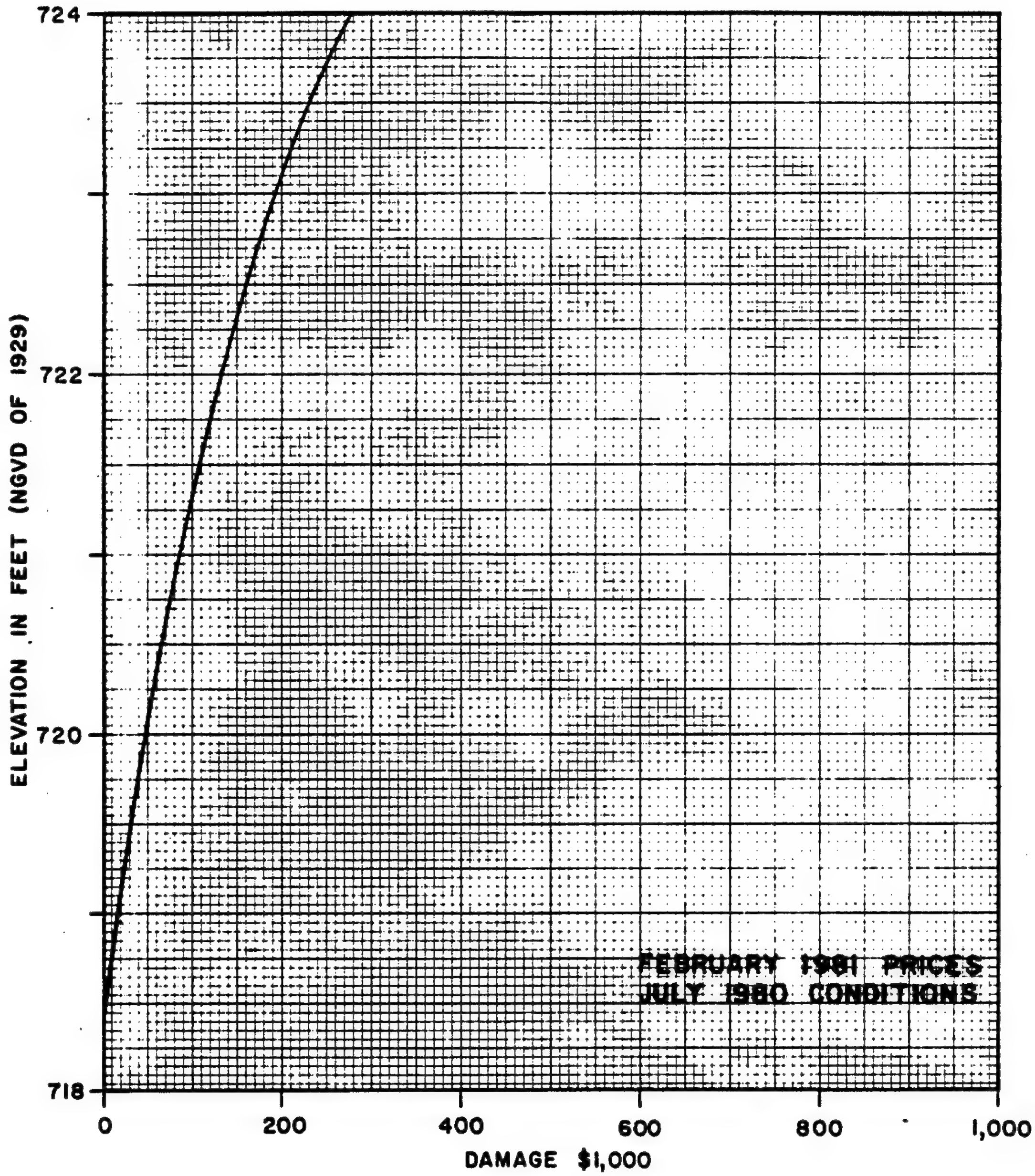
PLATE A-5



FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
FEATURE DESIGN MEMORANDUM
CHASKA CREEK

ELEVATION-AREA-STORAGE CURVES
CHASKA CREEK PONDING AREA
SECTION 1

ST. PAUL DISTRICT

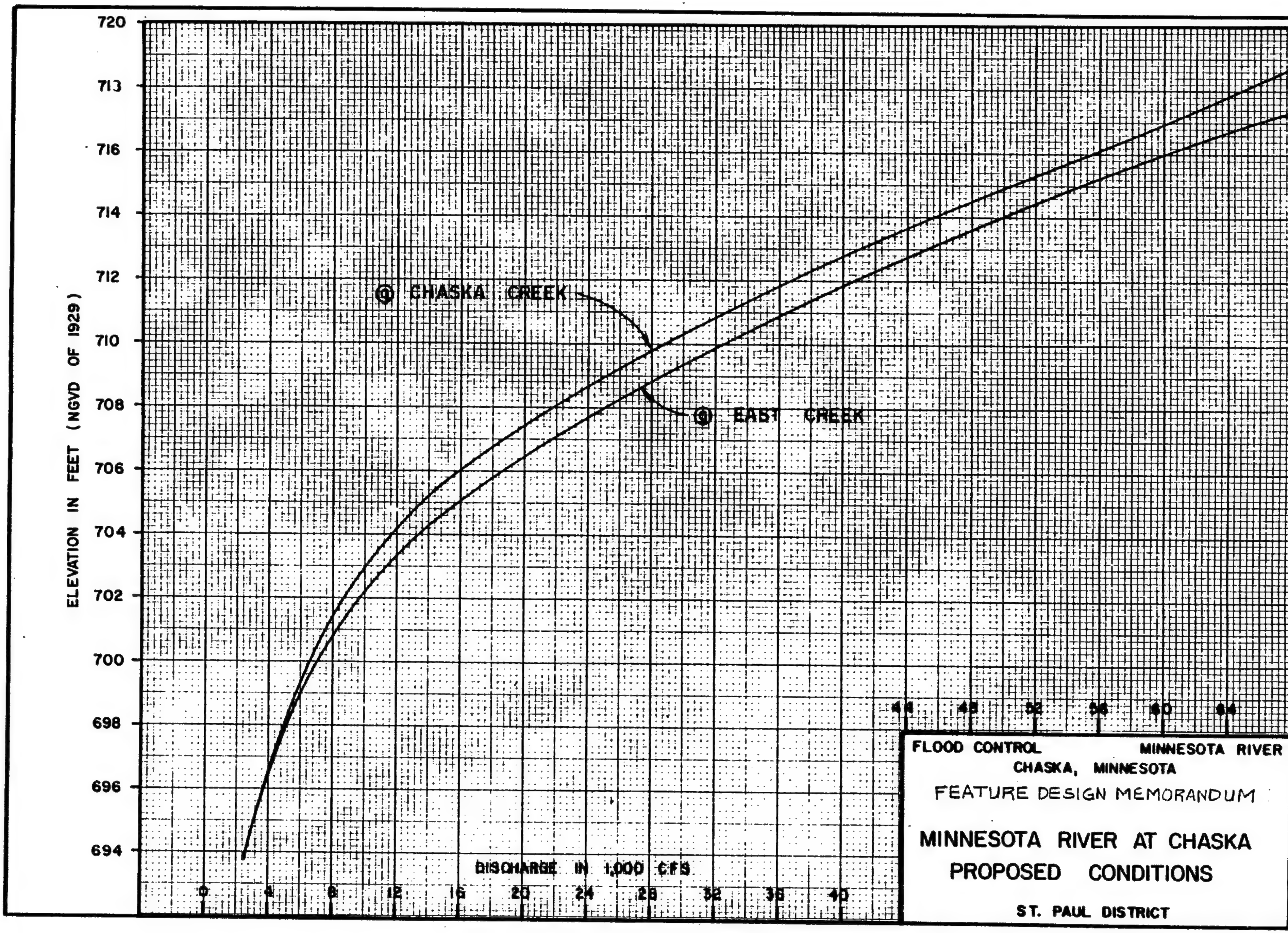


FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA

FEATURE DESIGN MEMORANDUM

DAMAGE-ELEVATION CURVE
SECTION I

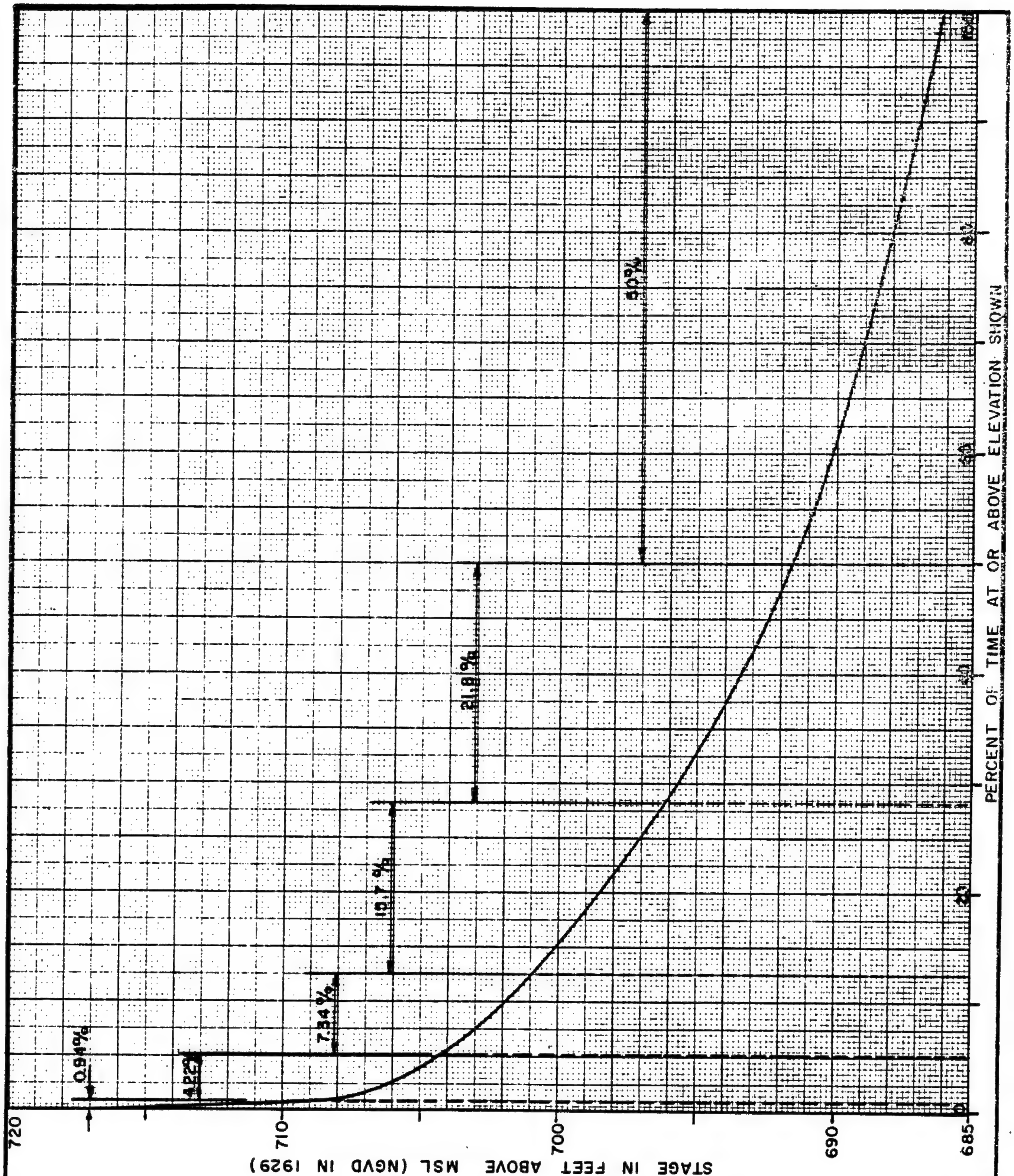
ST. PAUL DISTRICT



FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
FEATURE DESIGN MEMORANDUM

MINNESOTA RIVER AT CHASKA
PROPOSED CONDITIONS

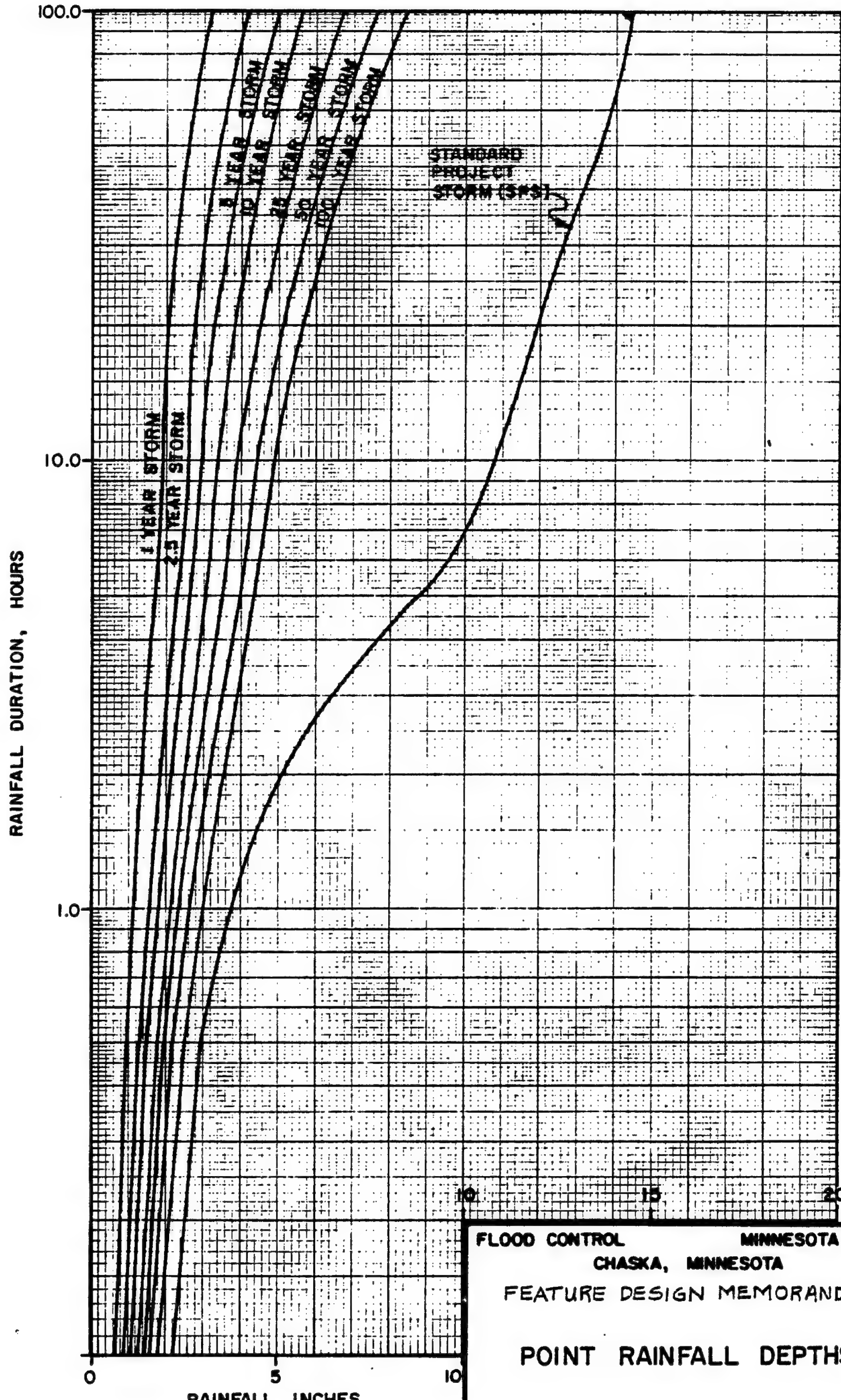
ST. PAUL DISTRICT



FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
FEATURE DESIGN MEMORANDUM

STAGE - DURATION CURVE MINNESOTA RIVER at CHASKA CREEK

ST. PAUL DISTRICT



FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
FEATURE DESIGN MEMORANDUM

POINT RAINFALL DEPTHS

ST. PAUL DISTRICT

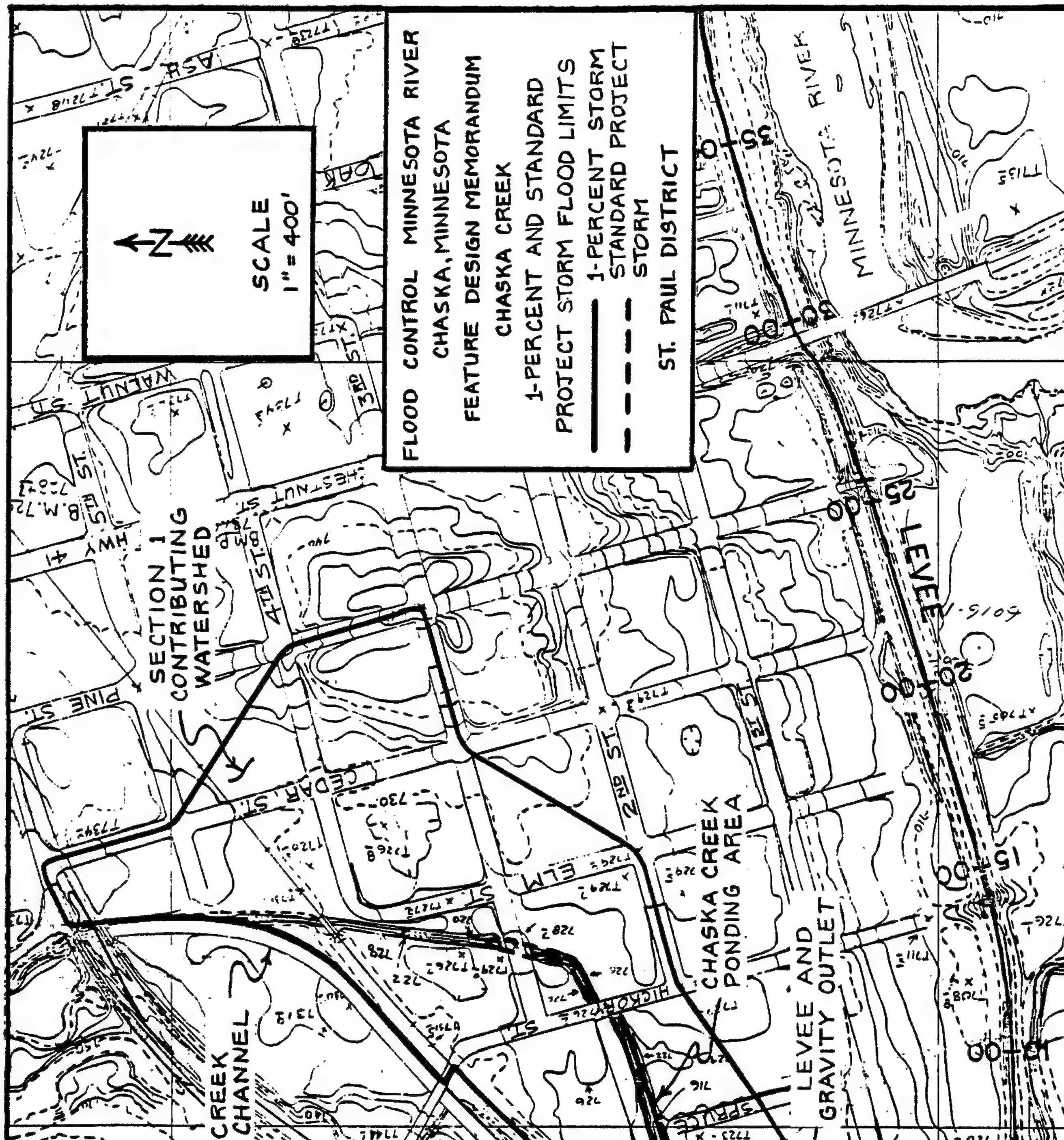

FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
FEATURE DESIGN MEMORANDUM
CHASKA CREEK
1-PERCENT AND STANDARD PROJECT STORM FLOOD LIMITS
1-PERCENT STORM
STANDARD PROJECT STORM
ST. PAUL DISTRICT
SCALE
1" = 400'
N
SECTION 1 CONTRIBUTING WATERSHED
CHASKA CREEK DIVERSION CHANNEL
CHASKA CREEK PONDING AREA
LEVEE AND GRAVITY OUTLET
LEVEE
MINNESOTA RIVER
PINE ST.
CEDAR ST.
ELM ST.
HICKORY ST.
SPRUCE
WALNUT ST.
CHESTNUT ST.
ASH ST.
OAK
HWY 41
2ND ST.
3RD ST.
4TH ST.
1ST ST.
5TH ST.

PLATE A-11

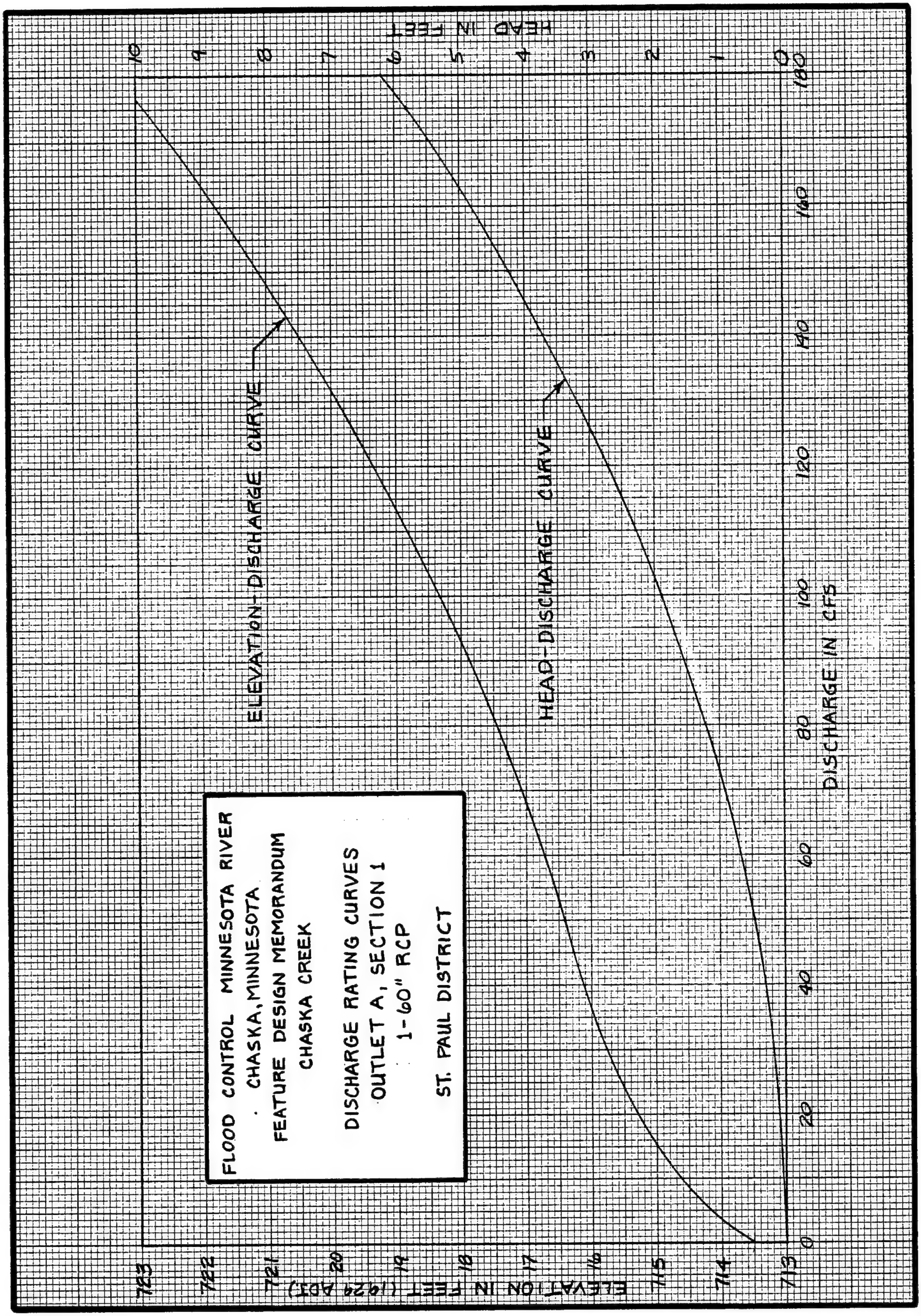

FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
FEATURE DESIGN MEMORANDUM
CHASKA CREEK
DISCHARGE RATING CURVES
OUTLET A, SECTION 1
1-60" RCP
ST. PAUL DISTRICT
ELEVATION-DISCHARGE CURVE
HEAD-DISCHARGE CURVE
HEAD IN FEET
0
1
2
3
4
5
6
7
8
9
10
ELEVATION IN FEET (1929 ADJ)
713
714
715
16
17
18
19
20
721
722
723
DISCHARGE IN CFS
0
20
40
60
80
100
120
140
160
180

PLATE A-12

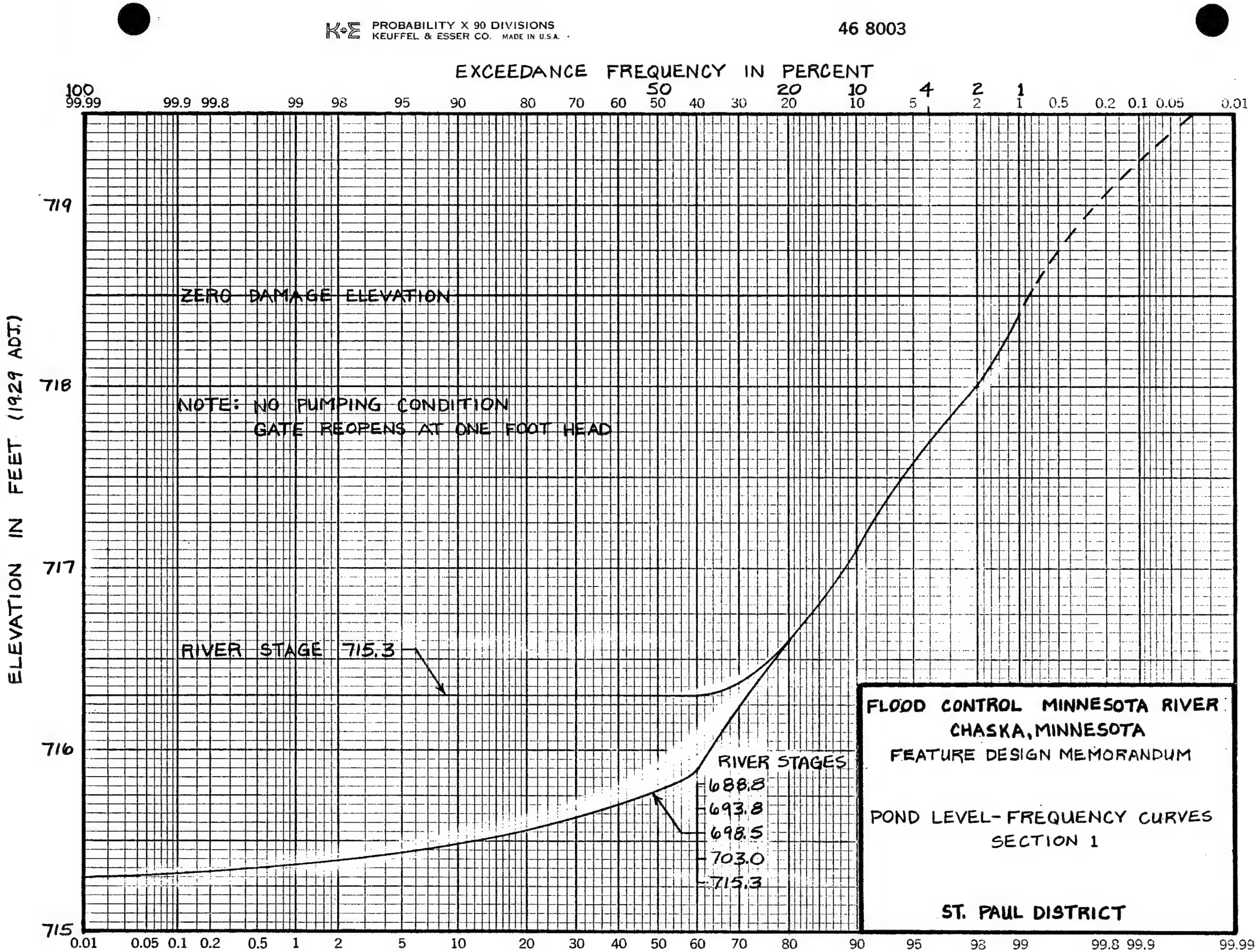

K+E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 8003
EXCEEDANCE FREQUENCY IN PERCENT
ELEVATION IN FEET (1929 ADJ.)
ZERO DAMAGE ELEVATION
NOTE: NO PUMPING CONDITION
GATE REOPENS AT ONE FOOT HEAD
RIVER STAGE 715.3
RIVER STAGES
688.8
693.8
698.5
703.0
715.3
FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
FEATURE DESIGN MEMORANDUM
POND LEVEL-FREQUENCY CURVES
SECTION 1
ST. PAUL DISTRICT

PLATE A-13

46 8003

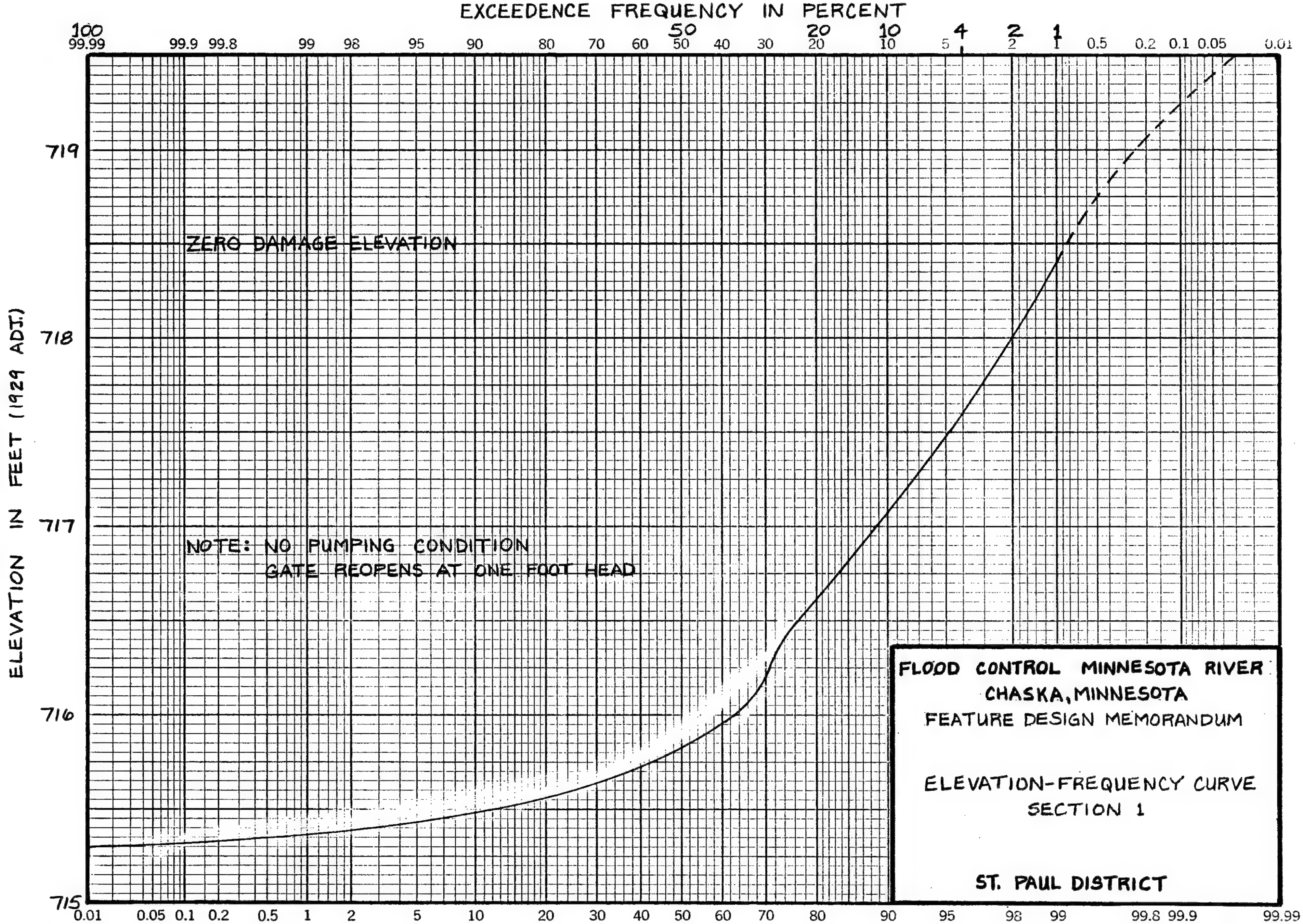


PLATE A-14

APPENDIX B

Geotechnical

APPENDIX B

GEOTECHNICAL

Table of Contents

Tables

Table of Contents (con.)

Figures

Plates

GEOTECHNICAL

INTRODUCTION

1. The city of Chaska is located in southern Carver County in the southwestern portion of the seven county metropolitan area that includes Minneapolis and St. Paul. The city is bounded to the south by the Minnesota River. Chanhassen to the east and northeast; Victoria to the northwest; and Carver to the southwest are the communities abutting the corporate limits of Chaska. Two major components drain over three-fourths of the incorporated area of the city. This project concerns the western drainage component referred to hereinafter as Chaska Creek. Chaska Creek drains the southwestern area of the city, discharging into the Minnesota River on the west side of the Chaska Old Town area.

TOPOGRAPHY

2. The portion of the city of Chaska encompassed in this project lies within the Minnesota River Valley. As Chaska Creek flows down to the Minnesota River from the highland area, it has cut a large ravine through the bluffs overlooking the river valley. The upland areas are rolling, containing long slopes, numerous surface depressions and irregular surface drainage. The hydraulic gradient increases sharply in the ravines carrying water through the bluff area and then flattens considerably upon entering the Minnesota River Valley's ancient glacial floodplain. The present river itself is grossly underfit for the wide valley cut by the Glacial River Warren, a much larger river that drained Glacial Lake Agassiz.

GEOLOGY AND SOILS

3. The geology influencing the project area is the result of the relatively recent geologic history of the glaciation activity during the Pleistocene Epoch and the carving action of the Glacial River Warren. The upland area consists of the rough knob and kettle topography that was formed on the east side of the Keewatin ice sheet. The hummocky surface is dotted with many small lakes and bogs. The glacier laid down a 200- to 250-foot thick layer of clayey, buff and gray drift over most of the upland areas in the county. Outwash sediments cap the drift over broad zones extending toward the Minnesota Valley. The rather extensive pockets of clay deposits indicate a ponding of the waters in the Minnesota River valley near the end of the glacial period. Terrace gravels occur on broad benches along the edge of the valley and frequently discharge water in the form of springs near the terrace edges. The portion of Chaska Creek contained in this project cuts through the alluvial sands, silts, and soft clays that cover the bedrock floor of the valley. These alluvium deposits range from 125 to 200 feet thick and are capped by laminated clays, which

again indicate ponding of the waters in the valley during the late stages of the glacial periods. Logs from city wells indicate the alluvium is underlain by the sandstones of the Jordan Formation, the shales and greensand of the St. Lawrence and Franconia Formations, and by the sandstone of the Dresbach Formation.

SUBSURFACE EXPLORATION

4. The subsurface investigation specifically for the Chaska Creek project was initiated in August of 1980 when two rotary borings were taken along the proposed alignment for the creek diversion. An additional boring was taken in March 1982, and six more obtained in October 1982. As the Chaska Creek Diversion channel became better delineated, 5 additional borings were obtained in August 1983. The logs for the St. Paul District borings are shown on plates B-2 through B-4. Test results may be found on plates B-6 through B-11. The 1980 through 1983 testing was performed by the Missouri River Division Lab.

5. As the Chaska Creek alignment was finalized, eight additional borings were obtained in February 1984 at the proposed bridge abutment locations to determine allowable bearing capacity for the bridge foundation material. The logs for the 1984 borings are presented on plate B-5. The location plan for all of the borings is shown on plate B-1. The 1984 logs and testing were performed by Soil Exploration Company. All test data are presented as received from the particular lab except as noted on the plates.

SUBSURFACE PROFILE

6. At the downstream end of the proposed creek diversion, two borings were taken near the proposed channel location (83-52M and 83-54M) that showed the channel foundation material consisted mostly of relatively weak silty sands and clayey sands. A U-U triaxial test taken from boring 83-54M indicated that the clayey sand is relatively weak with a cohesion value of 750 psf and an internal friction angle equal to 0 degrees. From boring 83-52M a U-U triaxial test showed the underlying clay layer to be relatively stiff with a cohesion value of 4,200 psf.

7. Moving upstream to the region between the First Street bridge and the Hickory Street bridge, the subsurface profile indicated a much less stable soil profile. In this region, the diversion channel is located between the Chicago and Northwestern Railroad and U.S. Highway 212. The topography and the soil conditions in this region make it the most critical with respect to stability. The borings taken for the First Street bridge and the railroad bridge indicated layers of soft muck and organic sandy clays (OL) separated by layers of loose silty sand. One of the bridge borings showed a muck layer as deep as 42 feet below the surface. Many of the blow counts in these bridge borings had values of 3 or less. Borings 82-37M and 82-39M, which are located near the proposed channel location and slightly upstream of the bridge borings,

did not show the same deep layered system of organic deposits, but rather consisted of layers of loose sands and silty sands. Borings 80-28M and 82-48M located 1,000 feet and 1,500 feet, respectively, upstream of First Street, showed generally silty sands, clayey sands, and clay layers with reasonably high blow count values. One notable exception was a 6-foot thick layer of soft sandy dark gray inorganic clay (CH) at a depth near the channel foundation elevation in boring 80-28M. In summary, the subsurface profile in this region showed very poor soils near the First Street and railroad bridges, and improving somewhat upstream toward the Hickory Street bridge.

8. The next region upstream, between the Hickory Street bridge and U.S. Highway 212, showed generally medium dense to dense silty sands interlain with layers of rather stiff lean clays. Two notable exceptions to this generalization were a soft organic silt layer from elevations 708 to 717 in boring 82-50M, and a medium stiff fat clay in boring 80-29M between elevations 707 and 714. This layer was also present in the Hickory Street bridge borings at a slightly higher elevation.

9. The borings for the region upstream of U.S. Highway 212 showed generally a fill layer consisting of silty sands and gravels overlying silt and clay layers. All of the silt and clay layers were reasonably stiff in nature ranging from a medium fat clay with a blow count of about 15 in a layer 15 to 25 feet below Hillside bridge, to a very dense silt near the bottom of several borings with blow counts approaching 50.

CHASKA CREEK CONCRETE DIVERSION CHANNEL

SOIL PARAMETERS FOR STRUCTURAL CALCULATIONS

10. The Modulus of Subgrade Reaction (k_s) is a strength parameter that defines a ratio between the unit soil pressure and the corresponding soil settlement. It is used to model the soil base as a set of "springs" with a value of compressiveness. In order to accurately determine the value of k_s, it would be necessary to perform a series of plate load tests. Since these tests are expensive and time consuming, a value of k_s equal to 400 kips/cubic feet was estimated (Bowles, 1968). The estimated value was based on the typical channel cross section shown on plate B-27. The 2.0-foot thick layer of free-draining granular material should provide an excellent base capable of producing a subgrade reaction of 400 kips/cubic foot or more. The use of only an estimated k_s value beneath the channel was also thought to be appropriate since the effect of the channel sections flexual rigidity will decidedly predominate in the channel/soil interaction and the value of k_s will have less importance. A value of 400 kips/cubic foot for the Modulus of Subgrade Reaction can be compared to a California Bearing Ratio (CBR) value of 15 or a Resistance Value (R) of 50 (source: National Crushed Stone Association).

11. The lateral earth pressure coefficient (k) used for design was based on a maximum backfill slope of 2H on 1V from the top of the channel wall. This is the steepest slope that can be reasonably maintained, and much of the project will be constructed at a flatter slope. The value of the coefficient of lateral earth pressure is classically broken into two states of limiting equilibrium.

a. The active state (k_a) in which the channel wall is moved away from the soil mass.

b. The passive state (k_p) in which the channel wall moves toward the soil mass.

Many researchers have literature containing the rotations and translations necessry to attain active and passive states of pressure. The commonly used rule of thumb is that the deflection at the top of the wall must be approximately 0.005 x height of wall to reach the condition of minimum active pressure. The amount of wall movement required to develop maximum passive pressures is much larger than the case of active pressures. A typical value of wall movement for a dense granular backfill is about 2 percent of the wall height. The soil may exert any force between the value of the minimum active and maximum passive pressure gainst the channel wall. The middle condition, called the at-rest condition (k_o) occurs when the wall remains motionless with respect to the soil.

12. The values for k_a and k_p shown in paragraph 4 of the structural appendix are computed from the Coulomb equation. The values of Coulomb's lateral earth pressure equation are tabulated in many

literatures for given soil parameters of cohesion and friction angle, and for various backfill angles. The frost-free material will definitely be a cohesionless granular material. The angle of internal friction, 0, was assumed to be 30° which is conservative for a material of the proposed type. The at-rest earth pressure coeficient (k_o) was determined from the empirical formula proposed by Jaky for level backfill:

$$k_o = 1 - \sin \phi$$

Since Jaky proposed no empirical modification to his equation for conditions other than level backfill, the following ratios were developed:

$$\frac{k_a \text{ (2:1 Backfill)}}{k_a \text{ (Level Backfill)}} \quad ; \quad \frac{k_p \text{ (2:1 Backfill)}}{k_p \text{ (Level Backfill)}}$$

The average of these two ratios was then applied to the k_o value for level backfill in order to determine a k_o value for 2:1 sloping backfill. For structural calculations, the at-rest coefficient (k_o) was assumed and then wall deflections were calculated to see if minimum active or maximum passive pressures would have been developed.

FROST PROTECTION

13. Channel flows during the winter months will be too low to adequately protect the soils beneath the concrete channel from freezing. Therefore, it is necessary to place a frost-free material below the concrete channel to prevent excessive movements of the ground beneath the channel as it freezes. There is no exact definition of a frost-free material, but research done by the Corps of Engineers indicates that frost heaving problems can generally be avoided by using materials that do not contain particles smaller than 0.02 millimeters in diameter.

14. A frost penetration analysis was, therefore, performed to determine the depth of frost-free material required. The analysis was done using one of the available equations relating the number of degree-days available during a freezing season to the depth of frost penetration. The number of degree-days, F, required for a layer of material to be fully penetrated by frost is calculated by the formula:

$$F = \frac{LH}{24}(R/2)$$ (Ref: Yoder, Principles of Design, 1965)

Where: F = degree-days
L = latent heat of fusion (BTU/FT^3)
H = thickness of layer (FT)
R = thermal resistance (BTU/FT^2-HR-F^o)

15. Since concrete has relatively poor thermal resistance properties, the frost depth during a severe winter with no snow covering the channel would be approximately 8 feet into the ground. The borings indicate that many of the in-situ soils are silty in nature. Such soils are generally considered to be the most susceptible to the formation of ice lenses and, therefore, to frost heaving. Because of the relatively high water table present throughout most of this project, it was felt that it would be prohibitively costly to attempt to remove all of the frost-susceptible soils to a depth of 8 feet below the concrete. It was, therefore, decided to use an insulation layer between the concrete channel and the frost-free material to prevent the frost from penetrating to such great depths.

16. When frost penetrates from the ground surface through two layers of material to a depth $h_1 + h_2$, or when heat flows up through layers h_2 and h_1, the total average thermal resistance is:

$$\frac{R_1 + (R_1 + R_2)}{2} = R_1 + \frac{R_2}{2}$$ (Ref: Thermal Soil Mechanics, 1966)

Since the insulation layer has no latent heat of fusion (L), it does not require any degree-days to penetrate the insulation itself, but it does increase the length of time that it takes for the frost to penetrate through the underlying layer. The total average thermal resistance of the frost-free layer with the insulation and the concrete above it is given:

$$\frac{R_1 + (R_1 + R_2)}{2} + \frac{(R_2 + R_3)}{2} = R_1 + R_2 + \frac{R_3}{2}$$

Therefore, the degree-days required to freeze the three-layered system of concrete, insulation, and frost-free material is given by the following equation:

$$F = L_1 h_1 (R_1) + L_3 h_3 (R_1 + R_2 + \frac{R_3}{2})$$

(Ref: Jumikis, Thermal Soil Mechanics, 1966)

Where: 1 = Concrete layer
2 = Insulation layer
3 = Frost-free material layer

17. The latent heat of fusion, (L_3), of the frost-free layer is directly proportional to the moisture content of the frost-free material. Based on the water level observations in the borings, the frost-free layer will most likely always be in the saturated condition with a resulting higher value for the latent heat of fusion. Based on this assumption, various combination of insulation thicknesses and frost-free material depths were tried and the resulting degree-days required to freeze through the frost-free layer calculated. The results of this analysis are summarized in table B-1 below.

Table B-1

Depth of Frost-Free Material	Insulation Thickness				
	0	1	2	3	4
0.5	236	461	686	911	1,136
1.0	417	867	1,317	1,767	2,217
1.5	608	1,283	1,958	2,633	3,308
2.0	808	1,708	2,608	3,508	4,408
2.5	1,018	2,143	3,268	4,393	5,518
3.0	1,238	2,588	3,938	5,288	6,638
4.0	1,706	3,507	5,307	7,106	8,907
5.0	2,213	4,464	6,714	8,963	11,214

18. Because of the relatively high water table encountered in the majority of this project, it was determined that it would be cost effective to limit the amount of excess excavation below the channel bottom as much as possible. In contradiction to this, it was determined that it would be desirable to maintain at least 18 inches of vertical separation between the bottom of the concrete slab and the water table. Therefore, 2.0 feet of granular material was selected as a desirable minimum amount of granular material that would provide the best balance between limiting the excavation quantity and still maintaining a reasonable dewaterable working base. Based upon

climatological data, a design degree day index of 2,600 was determined to be appropriate for this area. Winters exceeding 2,600 degree days have occurred only 4 times in the 60 year period between 1915 and 1975. Therefore, 2,600 degree days was determined to be an adequate level of protection. From table B-1, it is seen that 2.0 feet of frost-free granular material with two inches of insulation provides degree day protection of 2,600. With the additional protection of the 4 inch sand base beneath the concrete, the design section of 2 inches of insulation and 2.0 feet of frost-free granular material will provide the necessary degree days of frost penetration resistance. A detail section of the proposed insulation and granular material is shown on plate ·27.

SEEPAGE ANALYSIS

19. Due to the relatively high groundwater table encountered throughout most of the channel alignment, it was necessary to analyze the effects of seepage forces and their impact on the stability of the channel with regard to uplift. A detail showing a typical channel section and the proposed seepage control and frost protection measures is shown on plate B-27. The primary features of the seepage control system include 4-inch diameter weep holes spaced at 40 feet in the channel wall, a fully penetrating 4-inch diameter PVC drain pipe, a 2-foot thick layer of free-draining granular material all around the channel, and a geotextile fabric around the granular material. An outline of the seepage control design methods and assumptions is contained in the following paragraphs.

20. The soil profile along the length of the channel cannot be characterized by a typical profile. Materials range from gravel to fat clay in many individual borings at varying elevations. With soils this variable, the corresponding permeabilities vary by 5 or more orders of magnitude. The only feasible method to attack the problem was to estimate a conservative permeability for the in-situ materials as a whole. Permeabilities were estimated by analyzing the grain size distribution curves taken from borings along the channel at the appropriate elevation. This information is presented in table B-2:

Table B-2

Boring	Depth (ft)	Cu	D_{50}(mm)	k (cm/sec x 10^{-4})
83-54M	11.5	2.5	0.13	60
83-54M	15.5	3.9	0.28	60
83-52M	8.6	5.2	0.82	400
83-52M	16.5	3.2	0.22	70
82-40M	6.2	-	-	Impervious
82-40M	11.0	5.0	0.25	40
82-40M	16.5	53.9	5.0	Slow
82-48M	9.5	7.2	0.28	50
82-50M	6.5	2.4	0.3	500
83-56M	12.5	2.1	5.0	4000
83-56M	14.5	3.1	0.38	400
80-29M	16.2	32.2	3.0	Slow
80-28M	6.1	11.8	0.14	Slow
80-28M	9.2	3.5	0.35	300
82-37M	8.5	-	0.30	Slow
82-37M	17.9	6.4	0.55	70

From the above data, an average permeability was estimated to be 60 x 10^{-4} cm/second (reference: Powers, Construction Dewatering Figure 3.4).

21. Although a few borings indicate materials with permeabilities one or two orders of magnitude higher than the estimated average, the soils are so variable that it is doubtful that a large enough region of highly permeable material exists to significantly affect the subsequent calculations. Based on this average permeability, an average seepage quantity was estimated by using a mathematical model proposed by Powers (Construction Dewatering, Table 6.1) for water table flow from a line source to a drainage trench. The proposed channel was modelled as the drainage trench and the water table was assumed to be at the top of the channel. This assumption should be very conservative since the design water surface in the channel is two feet below the top of the channel. As part of the subsurface exploration for this memorandum, two piezometers were installed along the channel to monitor the groundwater response to a significant rainfall. One piezometer was installed near Hickory Street at channel station 45+15, at the approximate channel centerline. The other piezometer was installed near First Street at channel station 28+80, approximtely 12 feet right of the centerline of the channel. If the results of the piezometer readings indicate that the design assumption was too conservative, the seepage control design can be modified for the preparaton of plans. Using 60 x 10^{-4} cm/second for the average permeability, an estimated seepage quantity of 0.08 gpm/foot of channel is obtained using the above described assumption for the groundwater position.

22. The frost protection recommendation consisted of an insulation layer surrounded by 2.0 feet of frost-free material around the proposed channel. By specifying a poorly graded, coarse material for the frost-free material, it can be utilized as a collector trench to convey the seepage to the weep hole drainage pipes. The proposed gradation for the frost-free material is given in table B-3.

The frost-free material will hereinafter be referred to as free-draining granular material.

Table B-3

Sieve Size	Percent Passing
1"	100%
3/4"	75% - 100%
1/2"	55% - 80%
3/8"	45% - 70%
No. 4	20% - 50%
No. 10	0 - 30%
No. 60	0%

23. The minimum permeability that might be expected from a material meeting the gradation of table B-3 is 0.1 cm/sec. (Ref: Powers, Permeability and Capillarity of Drainage Materials, Fig. 8-5) by assuming a constant recharge rate of 0.08 gpm/ft of channel after a severe hydrological event and using a permeability of 1 x 10^{-1} cm/sec for the free-draining granular material various drain spacings were investigated. An 80-foot design spacing was chosen. With an 80-foot spacing, each drain would be required to take 6.4 gpm. Based on the U.S. Department of Interior "Drainage Manual" Figure 5-4, each drain has a capacity of 17 gpm. This provides a factor of safety (FS) of nearly 3.0. In addition, it was assumed that the drains would be rendered only 50% effective so that the final design spacing is 80 ft/22 - 40 feet. The slot size of the PVC drain pipe should be less than the D_{85} size of the free-draining granular material in order to pass filter criteria. (Ref: EM 1110-2-1913, Appendix E). From the gradation in table B-3, this corresponds to a 1/2-inch slot size. The PVC drain pipe should fully penetrate through the free-draining granular material so that the drain would still be effective if some frost penetration occurred through the wall of the channel. The end of the PVC drain pipe should be capped to prevent intrusion. A flap valve should be installed at the channel end of the drain pipe to prevent water from backing up into the granular material during periods of high channel flow or during periods of high backwater from the Minnesota River.

24. The critical reach of the channel with respect to seepage is between approximate channel sections 29+14 and 42+00. Although the borings do not indicate generally more pervious stratas in this reach, field observations indicate a very high groundwater condition on the north side of the channel. Therefore, in this reach an additional row of weep holes will be added on the north wall 3 feet above the channel invert and spaced midway between the regular weep holes. This will add an extra safety factor to this critical reach. If the design weep holes (1-foot row) should fail, the groundwater would simply rise to the level of the backup weep holes and flow into the channel.

25. To evaluate the performance of the seepage control system, an analysis was made that computed the duration of flow level in the channel to the time required for the drains to lower the groundwater surrounding the channel for the system shown on plate B-27. The ground water/drain system analysis was based on Figure 5-4 of the U.S. Department of Interior "Drainage Manual". The durations of various flows in the channel were taken from the standard project flood hydrograph. The results are listed in table B-4.

Table B-4

Depth of Flow In Channel (ft)	Time Elapsed between Maximum Flow Depth & Indicated Depth (hrs)	Time Required for Drains to Lower Groundwater to Indicated Depth (hrs)
6	4	0.7
5	6	1.3
4	8	2.0
3	11.5	3.0
2	16.5	4.5
1	30+	16.0

As shown in table B-4, the drain system is capable of lowering the surrounding groundwater faster than flow level decreases inside the channel. Therefore, the drain system is effective in preventing excessive uplift pressures.

26. In order to insure that the free-draining granular material does not become contaminated by the surrounding in-situ soils, it is recommended that a geotextile fabric be placed all around the free-draining granular material. The fabric would act as a separator to prevent the intrusion of the natural soils into the free-draining granular material, while allowing unrestricted drainage of the natural soil. It is recommended that the fabric be specified to conform to the parameters in table B-5.

Table B-5

Type	Woven
% open area	4%
E.O.S.	#50 - #70 U.S. Sieve
Grab Strength	200 lb. minimum
Puncture Strength	80 lb. minimum
Burst Strenth	160 psi minimum

SLOPE STABILITY

27. A slope stability overview was performed for the entire length of the Chaska Creek diversion channel. A computer program utilizing Bishop's method of slices was used to make quick checks on the FS resulting from the construction excavations in various regions of the diversion channel. The project was divided into four reaches. Each reach was analyzed by assuming a typical channel cross section representative of the reach as a whole. The intent of the slope stability overview was not to assign a definite FS to a given channel section, but rather to provide an indication as to whether or not slope stability may be a problem in a given area.

28. The results of the overview indicated that slope stability would be a problem for the reach between First Street and Hickory Street. Slope stability is a problem in this reach due to the combination of weak organic soils in the slope and higher cut sections because of the terrain. Slope instability is the most severe near the First Street bridge and gradually becomes less severe near the Hickory Street bridge. Near the First Street bridge the construction slope approaches 20 feet high and the soils are soft and organic. For this section, it is estimated that shoring of nearly the entire construction slope will be required using standard sheetpiling. Upstream of this point the soils are generally a little stronger and the construciton slopes are only 15 feet high. Using the U-U triaxial results of boring 80-28M, (C=800, 0=0), slopes of 10 feet will stand on a 1V on 1H construction slope. Therefore, it was estimated that the channel could be built by using timber sheeting up to the approximate elevation of the channel invert, and then continue the excavation up at a standard construction slope.

29. Shoring of some of the slopes in the reach upstream of U.S. Highway 212 will also be required. This is due not to the soil conditions, but instead to the lack of construction area. Slopes along County Road 10 and adjacent to the V.F.W. must be shored in order to prevent damage to the structures.

BEARING CAPACITY

30. The bearing capacity analysis of the bridge structures was accomplished by assuming that the proposed box culvert sections could be modelled as raft or mat foundations and foundation strength estimated from the SPT results. (Ref: Peck, Hanson, Thornburn, Foundation Engineering, 1953 Ch. 19). The Hickory Street bridge will be founded on a silty sand with blow counts ranging from 15 to 35. Conservatively, this material should produce an allowable bearing capacity of 4,400 p.s.f. Structural calculations show that the maximum anticipated soil pressure will be 3,318 p.s.f.

31. The Hillside Drive bridge will be founded on non-plastic silt or sand with blow counts of approximately 15. A conservative allowable bearing capacity of 3,000 p.s.f. was estimated for the Hillside Drive bridge. The structural design calaculations show an anticipated maximum soil pressure of 3,437 p.s.f. The allowable bearing capacity did not, however, take into account the unloading from removal of the existing timber bridge. The removal ofthe timber bridge will more than make up for the 437 p.s.f. discrepancy between the anticipated soil pressure and the estimated allowable bearing capacity. In addition, the long-term presence of the timber bridge indicates that the clay layer found in the bridge borings does not pose a tremendous settlement threat. For these reasons, it is anticipated that bearing capacity or settlement will not be a problem with this bridge.

32. The borings for the First Street and railroad bridges indicated the presence of very poor foundation soils to depths of 40 feet below the existing ground surface. Since the structural analysis showed that the soil pressures from the proposed structures would be greater than the surcharge removed from excavation, it was determined that that piling would be required to adequately support these structures. Treated timber piles with a load capacity of approximately 40 kips/pile would be used at this location. Piling lengths would be on the order of 45 feet deep at the railroad bridge and 40 feet deep at the First Street bridge. Depths are from the bottom of the proposed concrete channel.

33. Pile lengths were estimated statically using the profile of boring 84-69M for the railroad bridge and boring 84-70M for the First Street bridge. Both borings show stratas alternating from muck to sands and clays. Since it would be difficult at best to predict the termination layer, the end bearing portion of the total pile support was not taken directly into account (pile capacity = end bearing + friction). However, since end bearing will definitely be present to some degree, it was given credit indirectly by using an FS = 2.0 rather than a more customary 2.5.

34. Pile capacities for the cohesive stratas were estimated from the formula:

P = (c)(p)dL (Ref: M. J. Tomlinson, "Effects of Pile Driving and Skin Friction, 1971)

Where: P = pile capacity - lbs.
= coefficient to account for several effects that pile driving has on the adjacent soils
= 1.0 for soft overlying strata
= 0.7 for stiff underlying strata
c = cohesion (½ of unconfined compressive strength) - PSF
p = perimeter of the pile - ft

Pile capacities for the cohesionless stratas were estimated from the following formula:

P = 40(N)(p) dL (Ref: G. G. Meyerhoff "Penetration Tests and Bearing Capacity for Cohesionless Soils", 1956)

Where: P = pile capacity - lbs
N = blow count from SPT
p = perimeter of the pile - ft

For the cohesive soils, the cohesion was estimated from the blow count values. It should be stressed that the estimated piling length required to develop a 40 kip capacity is only an estimate based on the available soil and boring information. The actual pile length and capacity should be verified in the field at the time of driving. It is recommended that a dynamic pile analysis using the Case-Goble method be used to establish the driving criteria on the site. This method consists of measuring the force and acceleration in the pile at the time of driving. This information allows a determination of the maximum compressive force in the pile, predicted ultimate static bearing capacity, and energy transfer to the pile.

35. The 40 kip/pile capacity is based on the assumption that the levee alignment near the railroad bridge and the First Street bridge will be moved away from the proposed structures. The levee must be moved far enough away so that the influence pressure caused from raising the levee does not exert any force on the soft, compressible materials beneath the bridge structures. If this is not the case, then it is recommended that the piles be driven deeper in order to withstand the negative skin friction effects caused by settlement of the cohesive layers.

DISCUSSION & RECOMMENDATIONS

36. The recommended seepage control and frost protection design is shown on plate 27. In order to minimize frost intrusion into the free-draining granular material, it is recommended that Styrofoam RM insulation be placed both under the concrete channel and behind the vertical concrete sidewalls. Plate 27 shows 2 inches of insulation thickness and 2.0 feet of free-draining granular material underneath and behind the insulation. This was determined to be the optimum combination of insulation and granular material since a thicker granular layer would mean deeper construction accompanied by increased difficulty from groundwater and a thinner layer would not provide a thick enough de-waterable working base.

37. It is recommended that a geotextile fabric be placed between the free-draining granular material layer and the native soils. This is to protect the granular material from intrusion by the native soils, while still allowing free passage of water.

38. It is recommended that a 4-inch layer of sand be placed between the concrete channel bottom and the insulation. This would help facilitate the movement of water out of the concrete during curing. The insulation panels can be placed directly behind the vertical sidewalls. Specific details in regard to construction handling of the styrofoam could be obtained from Dow Chemical representatives.

39. The frost penetration design was based on a design freezing index of 2,600 degree-days which is in accordance with local climatalogical data. Based on this design freezing index, the section shown on plate B-27 will prevent frost from penetrating through the free-draining granular layer. The underlying natural soils are highly frost-susceptible; therefore, it is important to keep the frost front within the free-draining granular layer. We looked at both the free-draining granular layer being fully saturated and unsaturated. The frost will penetrate farther if the free-draining granular layer is unsaturated. However, the boring logs and field observations indicate that the groundwater will cause the free draining granula material to be in a saturated condition. Therefore, the design is based on a saturated condition. In the case where saturation of the free-draining granular layer is in existence during the winter, the frost will penetrate only partially into the free-draining granular layer. In order to prevent heaving of this free-draining granular layer, it is recommended that a very clean non-frost susceptible material be used. It is recommmended that the material conform to the grain size distribution shown in table B-3. This type of drainage material would satisfy both the frost problem and also the hydrostatic pressure relief system discussed later.

40. As the frost penetrates into the saturated free-draining granular layer, some freezing may occur. As the water freezes, pressures will be built up in the unfrozen water below the frost front. Heaving will not occur as long as these pore pressures do not exceed the downward pressure of the concrete structure. Because this is a closed system, no additional water will be drawn up from below creating ice lenses. Also the excess pore pressure developed in the water will relieve itself as the water rises somewhat in the unfrozen backfill. Therefore, it is our opinion that frost heaves will be negligible with this design. Also, any groundwater flow through the gravel layer during winter will tend to provide a convective heat transfer mode thereby decreasing the frost penetration depth into the gravel. Based on conversations with personnel from Dow Chemical, loss of insulating value of the Styrofoam SM due to exposure to water is negligible. It is our opinion that the 50-year design life would not be a problem for the insulating value of the styrofoam.

41. In order to relieve excessive uplift pressures due to the hydrostatic pressure from the anticipated high groundwater level, it is recommended that a series of weep holes be constructed through the channel walls at a point one foot above the channel invert. It is recommended that the weep holes be on a 40-foot spacing. The weep hole effectiveness was analyzed against two performance parameters. Firstly, the amount of groundwater entering the free-draining granular material from the adjacent native soils was calculated by estimating an average permeability for the native soils based on the grain size distribution curves and by assuming the water table was near the ground surface. The estimated groundwater infiltration rate is 0.08 gallons per minute per foot of channel on each side. The 40-foot weep hole spacing will accommodate all of this inflow. Secondly, the groundwater was assumed to be at the ground surface, and the water inside the channel was assumed to be at the standard project flood elevation. The time required for the weep holes to draw down the surrounding groundwater was then checked against elevations calculated from the discharge-duration curves. It was found that the weep holes would more than keep pace with the lowering of the water elevation inside the channel.

42. Normally, weep holes for retaining walls are built by constructing a 4-inch diameter hole in the wall and then placing a properly filtered backfill behind the hole. For better performance, it is recommended that fully penetrating weep hole drains be utilized. These drains would consist of 4-inch diameter PVC slotted drain pipe extending from the inside face of the channel wall back through the 2.0-foot free-draining granular layer. The outside end of this pipe should be capped. The slot in the drain pipe would be sized to pass filter criteria. It is also recommended that a flap valve be placed on the outlet of the weep hole drains. The purpose of the flap valve would be to prevent back flow into the free-draining granular material when the channel is full of water. In addition, it is recommended that the

upper two feet of the backfill material along the side of the channel be a random impervious material in order to minimize the surface water that gets into the free-draining granular material.

43. Based on the subsurface profile the critical channel reach is between First Street and Hickory Street. In this reach, it is recommended that an additional row of weep hole drains be installed midway between the regular weep hole drains and at an elevation three feet of the channel invert. This will progvode a backup system should the design weep holes fail to control the seepage quantity.

44. Because of the high groundwater conditions encountered throughout much of this project, the free-draining granular material will probably act as a drainage channel around the channel. In order to reduce the risk of contamination of the free-draining granular material with fines, sheet pile cutoff walls will be constructed at 450- to 500-foot intervals. The purpose of the cutoff walls is to stop the flow of groundwater in the free-draining granular layer and force it up into the weep hole drains. By forcing the water out of the free-draining granular layer and into the concrete channel at these intervals, the total quantity of water flowing in the free-draining granular layer can be kept down to a reasonable value.

45. During the winter months, the possibility of freezing various components of the seepage control system becomes a problem. The system is designed, however, so that it will still function under partially frozen conditions. Firstly, the fully penetrating weep hole drains will still be effective since even during the design winter, frost will only advance partially into the free-draining granular layer and there would still be some unfrozen length of the PVC drain pipe for the ground water to enter. Secondly, during the winter months, the ground water will probably lower and some of the weep holes may freeze because not enough water is flowing through to keep them open. However, the weep holes immediately upstream of the of the sheet pile cutoff walls should always have water flowing through them. It is well documented that continually flowing water will prevent a pipe from freezing.

46. A number of things should be done prior to and in conjunction with the preparation of the plans and specifications. The following recommendations are presented for consideration:

1) that the two peizometers continue to be monitored in order to verify adequacy of the groundwater level assumptions used in the calculations. It would be especially helpful to coordinate the monitoring of the piezometers with rainfall events. This would give a better idea of the groundwater table's response to rainfall;

2) that additional borings be taken in the critical reach of the channel (between First Street and Hickory Street). Gradations could be performed to get a better estimate of the permeability of the native

soils in this critical reach. Strength tests could be performed to get a better estimate of the bracing that will be required for construction of the excavation slopes;

3) that the railroad should be contacted again to see if detouring the rail traffic would be a reasonable alternative to the shoo-fly construction; and,

4) that a model of the typical channel section be constructed in order to monitor the performance of proposed seepage control and frost protection systems. The model should be constructed in the fall so that the frost penetration depth and heaving could be measured during the winter. Also the weep hole drain's susceptibility to freezing could be investigated.

CONSTUCTABILITY

47. The construction of the Chaska Creek concrete diversion channel will take two construction seasons. The phasing of the project is as follows: install railroad shoo-fly; construct railroad bridge, First Street bridge (Sta. 27+00 to 30+30); continue upstream concrete channel construction (Sta. 30+30 to 51+00 to end); and build Hillside bridge (Sta. 59+80).

48. The Chicago and Northwestern Railroad has indicated that they do not want to re-route rail traffic around Chaska to other facilities. Therefore, a shoo-fly track around the railroad bridge area is required. At this time, there is insufficient information available to compare the potential costs of re-routing rail traffic to the estimated cost of constructing the by-pass shoo-fly track. For the purposes of this analysis, a shoo-fly will be installed. This issue will be re-examined during final design of the project.

49. After completion of the shoo-fly and installation of a detour on First Street, the excavation for the new concrete channel will be accomplished. This excavation should extend downstream to Sta. 27+00, so that any accumulated seepage can be discharged into the existing Chaska Creek channel. Sheetpiling to support the side slopes is required in this area because of trench width restrictions imposed by the temporary shoo-fly and by slope stability limitations caused by the soil and groundwater conditions. Piling is required to support the bridge loadings. In the area where piling is required, the channel subgrade will be excavated and shaped, the geotextile fabric installed, and the free-draining granular material placed before driving the piles. The pile driving will puncture the fabric without excessive tearing or displacement.

50. The material excavated from the new channel area will be hauled away to a disposal area. This removal and disposal of excavated material will be coordinated with other parts of the overall project involving dike improvements. After the subgrade has been excavated and shaped to appropriate tolerance requirements, the geotextile fabric will be installed and covered with 2.0 feet of free-draining granular material. Groundwater will be removed to a sufficient depth to permit the shaping and tolerancing of the subgrade. Care will be required to avoid puncturing or tearing of the geotextile fabric during placement of the free-draining granular material. In some areas, it may be necessary to install temporary timber or metal sheeting to retain the side slopes, particularly at the bottom of the excavations near the granular material. The amount and extent of temporary sheeting or trench bracing will be related to the contractor's dewatering technique. Dewatering procedures will be left to the discretion of the contractor doing the work.

51. After installation of the free-draining granular material, the bottom slab will be formed and poured in 40-foot long panels or increments. The fine shaping of the surface of the granular material, the placement of the insulation and sand cover, and the placement of reinforcing steel can all take place within the forms prior to placement of concrete. A systematic pattern of construction procedures will be developed by the contractor as he moves upstream in 40-foot increments. The forming and pouring of the walls will also follow the bottom slab construction in 40-foot increments.

52. Prior to breaking into the existing Chaska Creek channel with the new concrete channel construction, the downstream outlet area will be complete. A short temporary by-pass channel can be excavated alongside of the construction area to convey the intermittent stream flow from Chaska Creek around the outlet structure.

53. Upstream of station 51+00, the existing Chaska Creek channel is located within the new concrete channel construction. There is no room to excavate a temporary by-pass channel around the project area, therefore, provisions will have to be made to accommodate any stream flow in Chaska Creek during construction.

54. Storm water flow in Chaska Creek only occurs during and for a short time after a rainfall event. A two-year frequency rainfall event occurring in the drainage basin will produce a peak design flow of 1,200 cfs, corresponding to a channel depth of 3.5 feet. Because the project will have a two-year duration, a storm of this magnitude can be expected, and a storm of a higher magnitude is possible. The installation and maintenance of temporary pumping equipment of sufficient capacity to completely by-pass intermittent stream flow during construction does not appear feasible. It is more reasonable to develop a construction technique that will allow stream flow to pass through the project area during construction upstream of station 51+00.

55. A technique is shown on a detail on plate 27. The critical element of this procedure is to prevent stream sediment and silt from contaminating the free-draining granular material during a heavy stream flow condition resulting from a storm. To accomplish this, the upstream sheet pile cut-off wall will be installed prior to excavating the downstream channel subgrade area. The top of the sheet pile cut-off wall will be temporarily left about two feet higher than the final design elevation, and the upstream channel excavated to subgrade elevation. This will form a sump or sediment trap to remove a significant portion of stream-laden sediment and larger silt particles. In addition, minor seepage and low volume flows during non-storm conditions can be pumped from this sump, aiding in dewatering for the downstream subgrade area.

56. After completion of the upstream sediment trap facility, the downstream channel subgrade will be excavated and shaped to the required tolerance. The geotextile fabric and the free-draining granular material installation will proceed upstream from the completed concrete channel section. Concurrent with placement of the granular material is the immediate placement of a temporary geotextile filter fabric over the top of the granular material. This temporary filter fabric must be securely anchored at the upstream end and along the sides of the excavation. As the bottom slab panels are formed, the temporary filter fabric can be rolled back as required to permit placement of insulation, sand cover, and reinforcing steel within the formed panel. When the bottom slab construction approaches the sheet pile cut-off wall, the piles will have to be driven to final elevation and the above process repeated.

57. Should a storm occur during this process, construction will be temporarily suspended until the stream flow has passed on through. Larger sediment and silt particles will be deposited in the upstream sump area. There will be a short-duration downward flow of water through the geotextile filter fabric until the granular material below becomes saturated. After that, the stream flow will flush any silt downstream through the completed channel section. After subsidence of the stream flow, there will be a second short-duration downward flow through the geotextile filter fabric as the entrapped water below the base slab is pumped out of the free-draining granular material with sump pumps as required. The geotextile filter fabric is then rolled back for forming of the next bottom slab panel.

58. Some sheetpiling or trench bracing will probably be required north of TH 212 because of the limitations of trench width required by the adjacent county road. A relativelly high ground water condition can also be expected in this area.

CHASKA LEVEE SLOPE STABILITY

GENERAL

59. An analysis of the slope stability of the levee and channel configuration, at station 19+19 on the Chaska Creek diversion channel, was conducted to determine the factor of safety against embankment sliding for the cases outlined in EM 1110-2-1913 entitled, "Design and Construction of Levees." The analysis was completed using the Corps library computer programs I0013 (Slip Circle Slope Stability with Side Forces) and I0014 (Slope Stability Using Generalized Failure Surfaces). The section chosen for the analysis was considered to be the most critical section along the Chaska Creek alignment since the levee was only ±100 feet from the channel and the channel is at its lowest elevation (the bottom of the preformed scour hole downstream of the last drop structure). The cases analyzed included end of construction, end of construction with high water, intermediate flood stage, and steady seepage. The sudden drawdown case was not completed since the Minnesota River characteristically drops from flood stage very slowly. Subsequent to performing the stability analyses, the drop structure was moved upstream approximately 200 feet, which moves the preformed scour hole closer to the levee. Because of time constraints, the stability of the levee was not reanalyzed. Consequently, the stability will have to be reanalyzed during the plans and specifications stage to determine if levee realignment (setback) is required to assure levee stability adjacent to the preformed scour hole.

SOIL PARAMETERS

60. The results of the stability analysis are based on soil parameters obtained from testing on the following borings: 80-24MU, 83-52MU, 83-54MU, 83-55MU, 83-59MU, 83-60MU, and 83-61MU. Although boring 80-24MU was taken as an undisturbed bore hole, sample number 1 was disturbed and tested as a remolded sample. The values obtained from that test were used to represent the remolded levee fill (Q-test only). All soil test data are shown on plates B-6 through B-8. The soil parameters selected for use in the analysis are shown in the following table.

Table B-6
Design Soil Parameters Used in COE Slope Stability Analysis

	Q-Test		R-Test		S-Test		(R+S)/2	
Soil Layer	Cohesion (PSF)	0 (DEG)	Cohesion (PSF)	0 (DEG)	Cohesion (PSF)	0 (DEG)	Cohesion (PSF)	0 (DEG)
1*	500	23	200	16	0	28	100	22
2	800	22.5	780	22.3	0	30	390	26.15
3**	0	30	0	30	0	30	0	30
4	4360	0	1350	9.5	0	30	675	19.75
5	710	0	1100	10	0	37	550	23.5

*Remolded parameters - R and S values are assumed.
**Soil parameters are assumed for sand.

END OF CONSTRUCTION

61. The end of construction case results are shown on figures B-1 through B-9, and tabulated in table B-7. Figures B-1 and B-2 show some of the circular arcs analyzed for the scour hole slope and the riverside slope of the levee, respectively. The minimum circular arcs for these slopes were joined by a plane and used as a starting point for the generalized slope stability analysis shown on figures B-3 through B-5. This is presented as the minimum or critical failure surface for riverside levee/channel end of construction case; however, the scour hole slope alone has a minimum factor of safety of 1.82. The landside end of construction case was analyzed, assuming a high water condition (as required by EM 1110-2-1913), and a pheatic surface that fully saturates the existing levee, but not the proposed levee prism. This is an extreme case and the factor of safety far exceeds the required value of 1.30. Some of the trial arcs are illustrated on figure B-6, and figures B-7 through B-9 show the minimum or critical failure surface.

STEADY STATE SEEPAGE

62. This case was analyzed for the sake of completeness. It is very unlikely that the embankment will become fully saturated. Several trial arcs are illustrated in figure B-10, and figures B-11 through B-13 show the minimum or critical failure surface. The results of the analysis are summarized in table B-7.

INTERMEDIATE FLOOD STAGE

63. Because of the geometry of the problem the analysis was conducted for "deep" and "shallow" arcs. The critical pool elevations of the levee were determined to be 717.5 for "deep" arcs, and 714.0 for "shallow" arcs. Figure B-14 illustrates the results obtained for each

case. For this analysis a "deep" arc was defined as any arc tangent to a line drawn parallel to the riverside slope inset a distance equal to 25% of the embankment height (4.4 feet in this case), or deeper. Many arcs were analyzed, but in each case the arbitrarily defined "deep" arcs were found to be the minimum arcs with respect to the various pool elevations. Figure B-15 shows several of the arcs used in the analysis of the "deep" arcs. Figures B-16 through B-18 illustrate the minimum or critical "deep" arc case. The shallow arcs tend to be geometry dependent with respect to the remolded fill shown on figure B-19. The minimum or critical failure surface for shallow arcs is illustrated on figures B-19 through B-20. The results are summarized in table B-7.

Table B-7

Chaska Levee Slope Stability Summary of Results
Station 19+19

Stability Case		Factor of Safety Required*	Factor of Safety Computed
I	End of Construction	1.30	3.30
II	End of Construction (landside w/ high water)	1.30	3.14
III	Sudden Drawdown	1.00	N/A
IV	Intermediate Flood Stage		
	(deep)	1.40	1.69
	(shallow)	1.40	1.53
V	Steady Seepage from Full Flood Stage	1.40	1.43

* As stated in EM 1110-2-1913

CHASKA LEVEE SEEPAGE AND UPLIFT

64. A detailed seepage analysis was performed for the Phase II General Design Memorandum (GDM), dated February 1984. As a result of that analysis, certain remedial measures were recommended for the Chaska levee. Part of the levee covered under this Feature Design Memorandum was recommended to have a landside seepage berm constructed; however, many of the NCD comments on seepage and uplift were deferrred to the Chaska Levee Feature Design Memorandum yet to be completed. As a result, all further design and construction of the seepage and uplift remedial measures shall be deferred to that report. The proposed levee will be part of this feature, and the final seepage and uplift remedial

measures shall be added at a later date. Figures B-21 through B-26 have been reproduced from the Phase II GDM showing design computations for the Chaska levee between station 20+00 and station 38+00 of the Chaska Creek diversion channel alignment. The minimum factor of safety versus uplift pressures for this reach is 1.76, which exceeds the required factor of safety of 1.50.

SETTLEMENT

65. A computation to check the change in stress at the channel due to the Chaska levee was conducted using the Corps Library Program I0016, entitled "Vertical Stresses Beneath Embankment and Footing Loadings."

At the closest point, the toe of levee is 80 feet from the channel. A section was taken at station 83+44 along the Chaska levee alignment as shown in Figure B-27. Using the principle of superposition, it was determined that a net decrease in stress of approximately 1100 psf will occur at the base of the concrete channel. Therefore, settlement problems will not occur, and rebound in the soils encountered at Chaska Creek seems unlikely. Figure B-28 shows the results of the change in stress computation at station 83+44 due to the levee for both existing and proposed conditions.

SOURCE OF CONSTRUCTION MATERIALS

RIPRAP AND BEDDING

66. Riprap and bedding of adequate quality can be obtained from limestone quarries, developed in the Prairie du Chien Formation, located on the south side of the Minnesota River valley within 10 miles of Chaska.

CONCRETE AGGREGATE

67. Concrete aggregate of adequate quality can be obtained from continuously operating natural aggregate and crushed rock sources in the Minneapolis-St. Paul, Minnesota, metropolitan area. The distance from the project to reliable sources in this area would be 25 to 50 miles. Closer sources located within 10 miles of Chaska exist but produce concrete aggregate on an intermittent basis. Although the closer sources have not been tested or used for Corps of Engineer projects, informatin obtained from the Minnesota Department of Transportation indicates this material would be adequate as a concrete aggregate.

LEVEE FILL

68. Levee fill would consist of useable material obtained from the channel excavations. A plentiful supply of impervious glacial fill is available from the surrounding uplands in the event sufficient quantities are not obtainable from channel excavations.

FREE DRAINING GRANULAR FILL

69. Free draining granular fill can be obtained commercially from gravel pits located within 10 to 15 miles of Chaska.

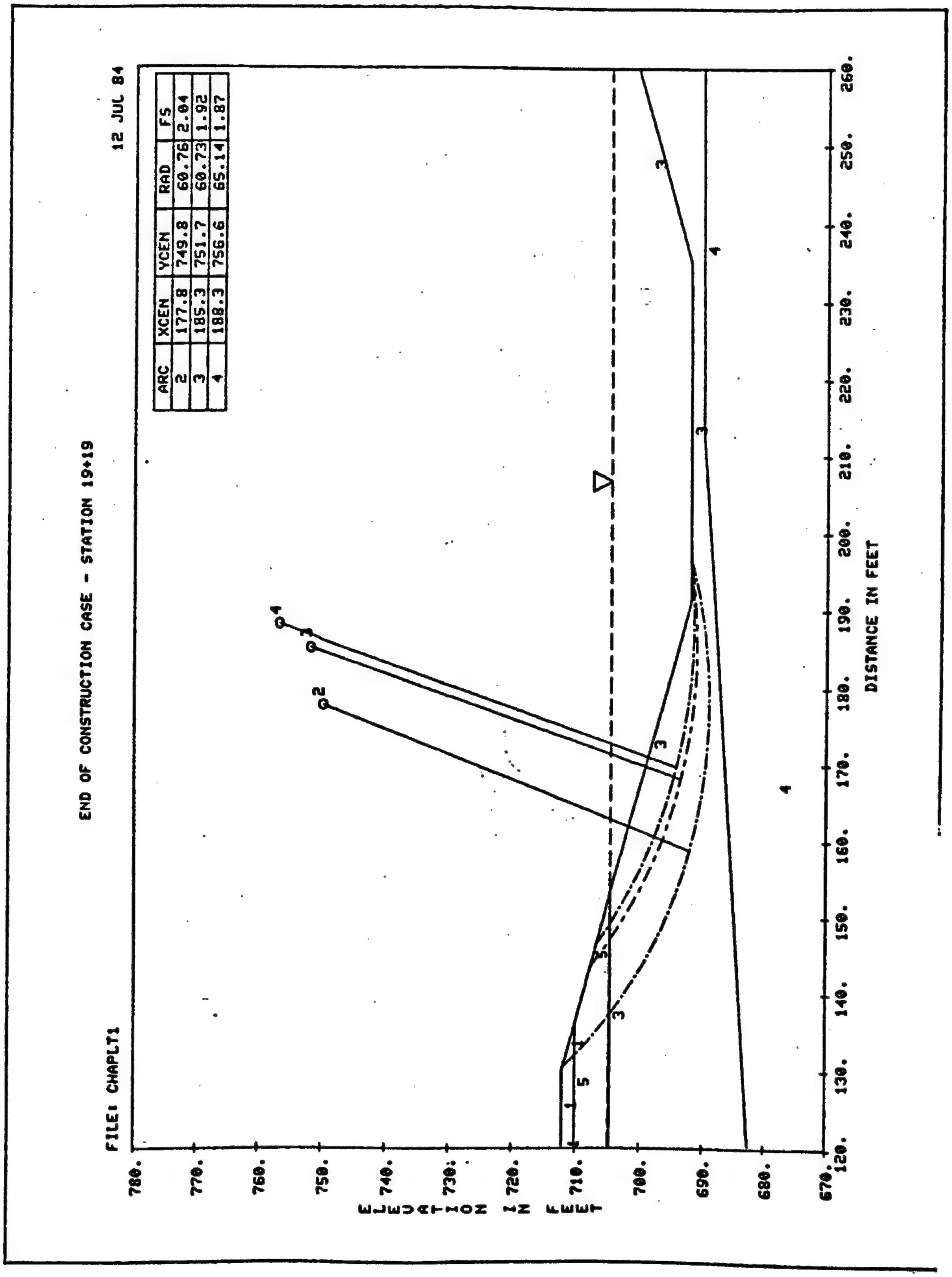

END OF CONSTRUCTION CASE - STATION 19+19
12 JUL 84
FILE: CHAPLT1
ARC XCEN YCEN RAD FS
2 177.8 749.8 60.76 2.04
3 185.3 751.7 60.73 1.92
4 188.3 756.6 65.14 1.87
DISTANCE IN FEET
ELEVATION IN FEET

Figure B-1

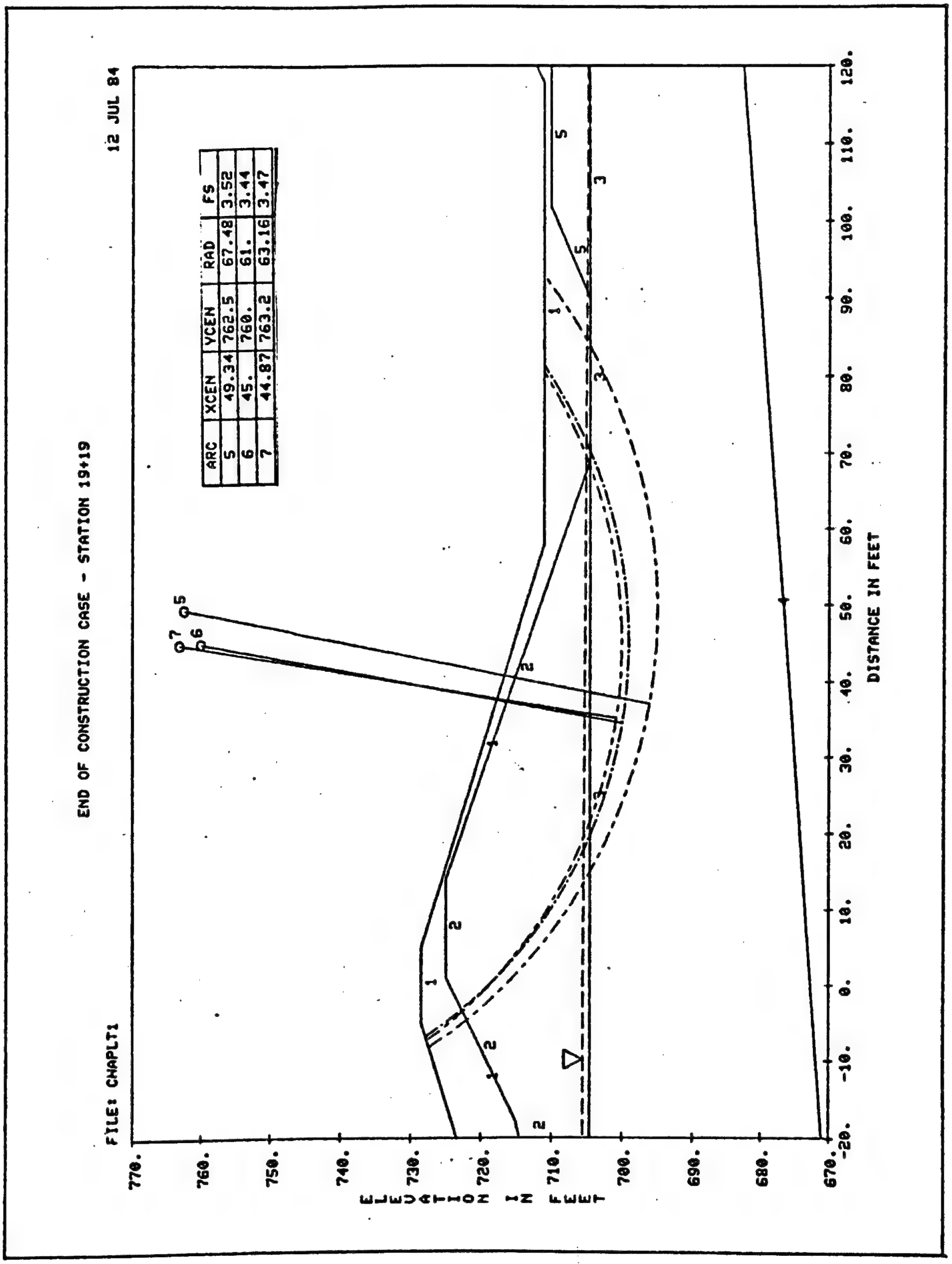

END OF CONSTRUCTION CASE - STATION 19+19
12 JUL 84
FILE: CHAPLT1
ARC XCEN YCEN RAD FS
5 49.34 762.5 67.48 3.52
6 45. 760. 61. 3.44
7 44.87 763.2 63.16 3.47
DISTANCE IN FEET
ELEVATION IN FEET

Figure B-2

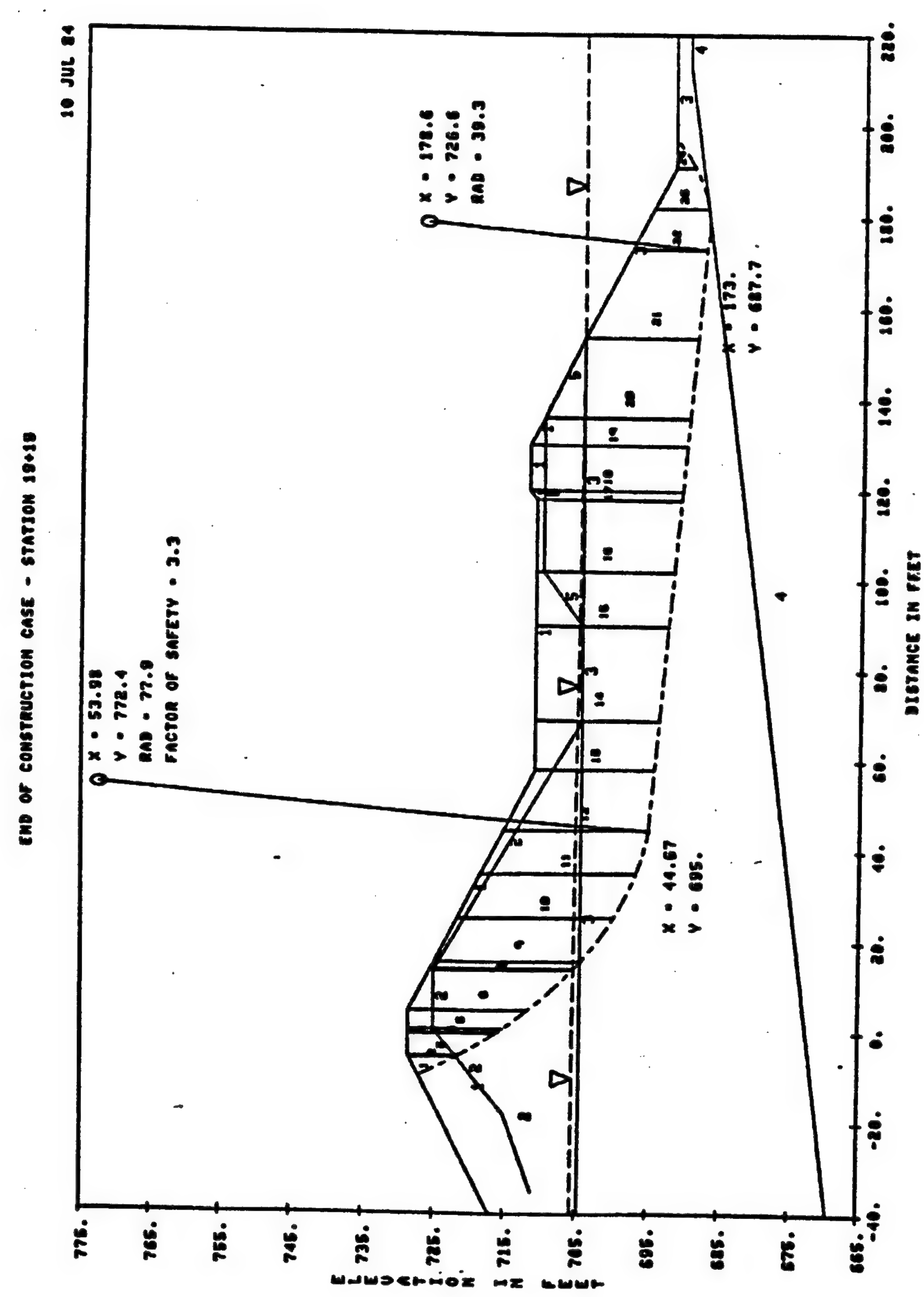
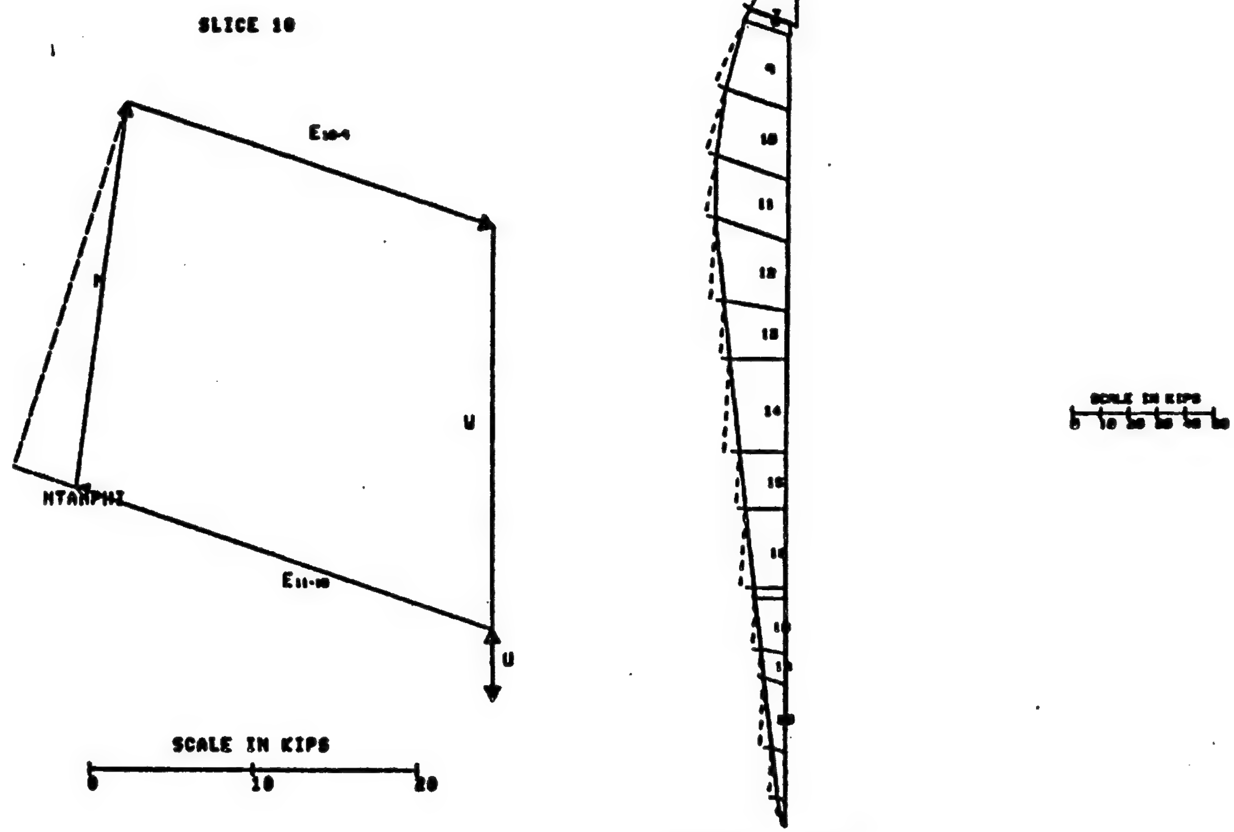

END OF CONSTRUCTION CASE - STATION 19+18
10 JUL 84
X = 53.98
Y = 772.4
RAD = 77.9
FACTOR OF SAFETY = 3.3
X = 178.6
Y = 726.6
RAD = 39.3
X = 44.67
Y = 695.
X = 173.
Y = 687.7
DISTANCE IN FEET
ELEVATION IN FEET

Figure B-3

END OF CONSTRUCTION CASE - STATION 19+10
FORCE DIAGRAM

10 JUL 84



ERROR OF CLOSURE 0.

Figure B-4

END OF CONSTRUCTION CASE - STATION 19+19

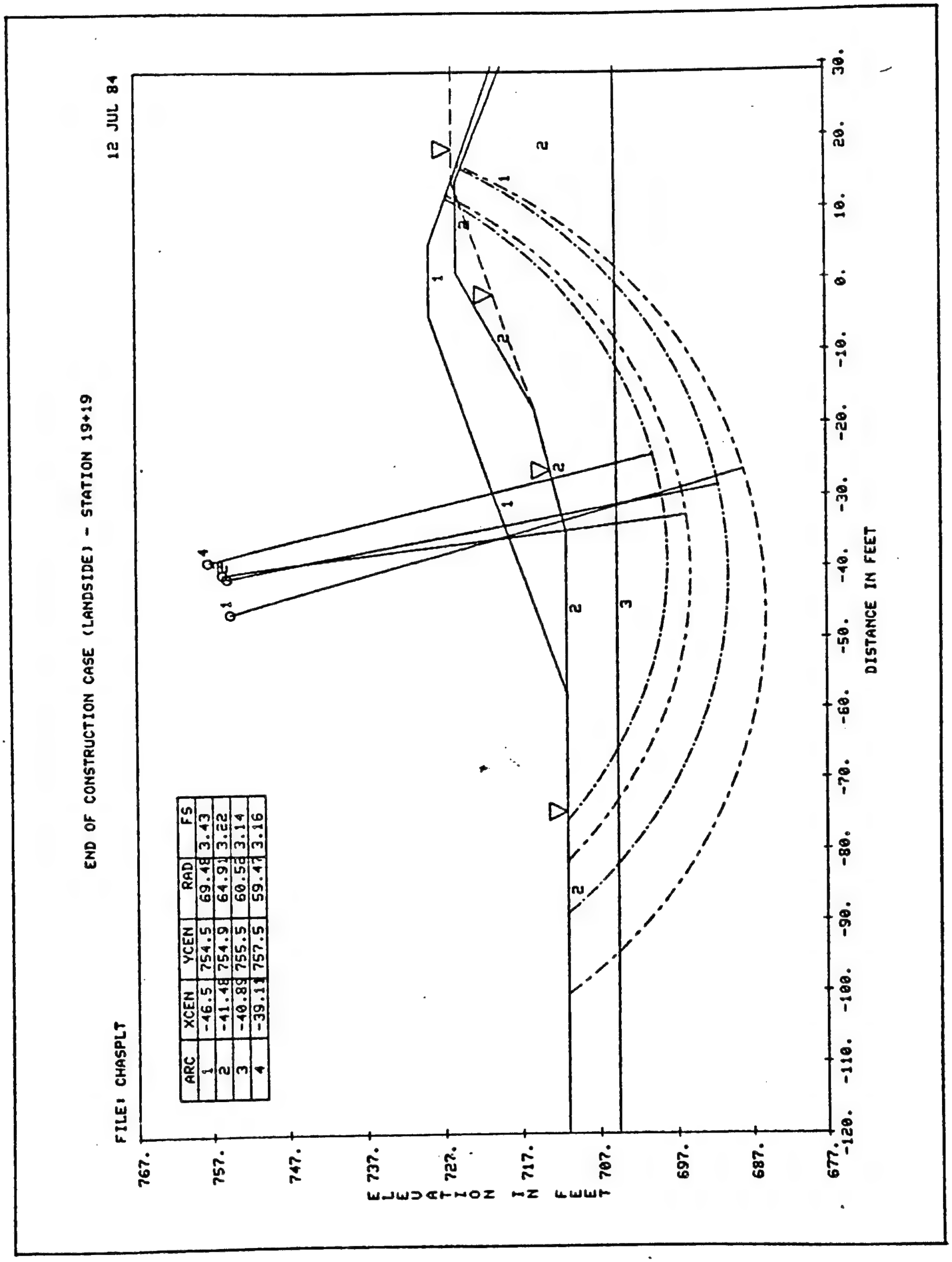
TABULATION OF SLICE DATA

10 JUL 84

SLICE	SLICE WIDTH	SLICE COORD	SLICE WT	WATER FORCE	DIRECTION	DEVEL C-FORCE	DIRECTION	PHI DEVEL	NORM STRESS	NORM FORCE	ALPHA TOP	ALPHA BOT	E1	E2
1	4.17	-7.28	1.73	0.	0.	1.02	-51.93	.7	.22	1.47	0.	0.	0.	.52
2	.2	-5.1	.17	0.	0.	.07	-49.33	7.14	.5	.15	0.	0.	.52	.57
3	5.	-2.5	6.25	0.	0.	1.76	-46.54	7.14	.88	6.39	0.	0.	.57	3.45
4	1.	.5	1.7	0.	0.	.33	-43.36	7.14	1.31	1.81	0.	0.	3.45	4.28
5	4.	3.	8.02	0.	0.	1.28	-40.91	7.14	1.35	7.17	0.	-9.14	4.28	7.42
6	9.	9.5	22.42	0.	0.	2.66	-34.92	7.14	1.77	19.47	-9.14	-18.27	7.42	15.05
7	.21	14.1	.57	0.	0.	.06	-30.79	7.14	2.18	.53	-18.27	-18.27	15.05	15.22
8	1.57	14.99	4.35	.04	90.37	.44	-30.04	7.14	2.2	3.98	-18.27	-18.27	15.22	16.47
9	9.63	20.59	27.73	1.9	90.37	0.	-25.45	9.91	2.27	24.19	-18.27	-18.27	16.47	23.41
10	9.63	30.22	28.27	4.17	90.37	0.	-17.8	9.91	2.27	22.92	-18.27	-18.27	23.41	26.8
11	9.63	39.85	27.06	5.59	90.37	0.	-10.47	9.91	2.15	21.07	-18.27	-18.27	26.8	27.06
12	13.33	51.33	32.63	8.73	90.37	0.	-3.26	9.91	2.14	28.54	-18.27	-9.14	27.06	22.68
13	11.	63.5	24.24	7.83	90.37	0.	-3.26	9.91	1.82	20.04	-9.14	0.	22.68	20.09
14	21.	79.5	48.23	15.62	90.37	0.	-3.26	9.91	1.54	32.34	0.	0.	20.09	16.39
15	12.	96.	29.16	9.55	90.37	0.	-3.26	9.91	1.62	19.45	0.	0.	16.39	14.17
16	16.	110.	40.8	13.44	90.37	0.	-3.26	9.91	1.69	27.14	0.	0.	14.17	11.06
17	2.	119.	5.36	1.74	90.37	0.	-3.26	9.91	1.79	3.59	0.	0.	11.06	10.65
18	10.	125.	27.85	8.87	90.37	0.	-3.26	9.91	1.74	17.43	0.	-9.22	10.65	8.78
19	6.	133.	16.32	5.47	90.37	0.	-3.26	9.91	1.62	9.73	-9.22	-17.94	8.78	7.94
20	17.5	144.7	40.72	16.61	90.37	0.	-3.26	9.91	1.42	24.81	-17.94	-17.94	7.94	4.99
21	19.51	163.2	38.87	15.77	90.	0.	-3.26	9.91	.9	17.59	-17.94	-18.43	4.99	2.82
22	9.	177.5	10.39	4.99	90.	0.	-1.55	9.91	.63	5.66	-18.43	-18.43	2.82	1.94
23	9.	186.5	5.93	2.85	90.	0.	11.74	9.91	.42	3.85	-18.43	-9.22	1.94	.41
24	8.12	194.1	1.05	.5	90.	0.	23.33	9.91	.11	.72	-9.22	0.	.41	0.

ALL FORCES IN KIPS
ALL ANGLES MEASURED FROM POSITIVE X-AXIS

Figure B-5

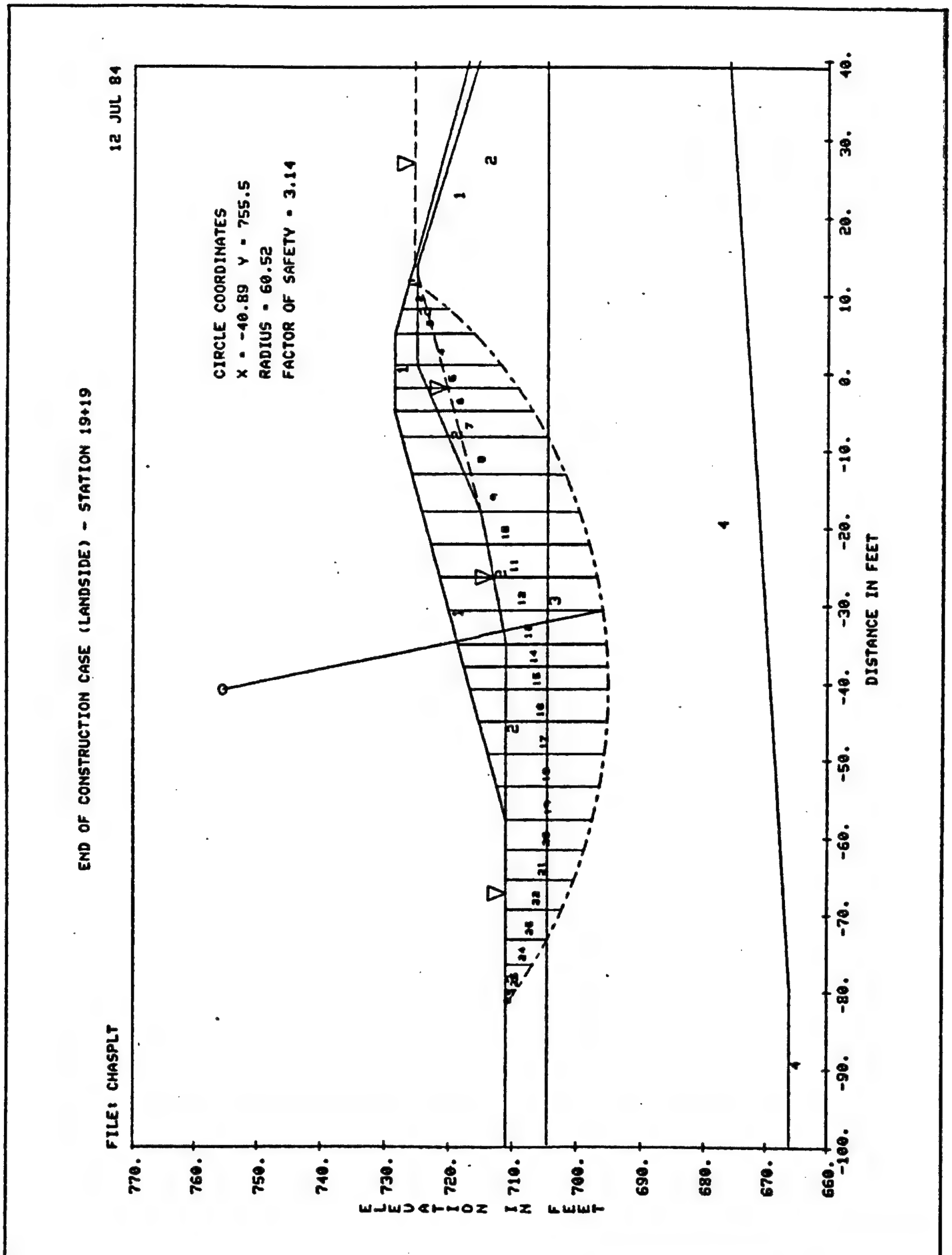


END OF CONSTRUCTION CASE (LANDSIDE) - STATION 19+19
12 JUL 84
FILE: CHASPLT

ARC	XCEN	YCEN	RAD	FS
1	-46.5	754.5	69.48	3.43
2	-41.48	754.9	64.91	3.22
3	-40.89	755.5	60.56	3.14
4	-39.11	757.5	59.47	3.16

ELEVATION IN FEET
DISTANCE IN FEET

Figure B-6



END OF CONSTRUCTION CASE (LANDSIDE) - STATION 19+19
FILE: CHASPLT
12 JUL 84
CIRCLE COORDINATES
X = -40.89 Y = 755.5
RADIUS = 60.52
FACTOR OF SAFETY = 3.14
ELEVATION IN FEET
DISTANCE IN FEET
770.
760.
750.
740.
730.
720.
710.
700.
690.
680.
670.
660.
-100.
-90.
-80.
-70.
-60.
-50.
-40.
-30.
-20.
-10.
0.
10.
20.
30.
40.

Figure B-7

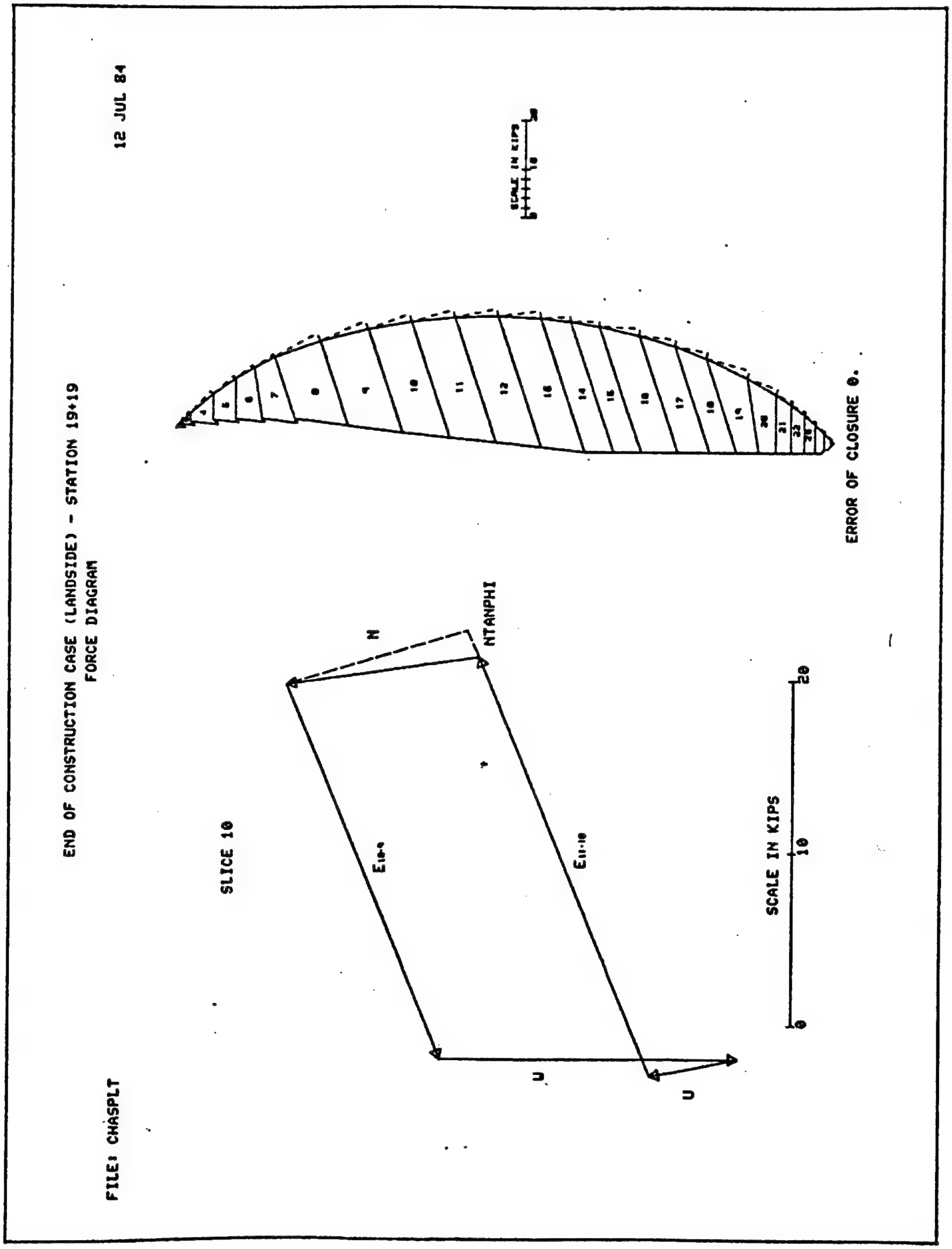

END OF CONSTRUCTION CASE (LANDSIDE) - STATION 19+19
FORCE DIAGRAM
12 JUL 84
SLICE 10
N
NTANPHI
U
U
SCALE IN KIPS
0
10
20
ERROR OF CLOSURE 0.
FILE: CHASPLT

Figure B-8

END OF CONSTRUCTION CASE (LANDSIDE) - STATION 19+19

TABULATION OF SLICE DATA

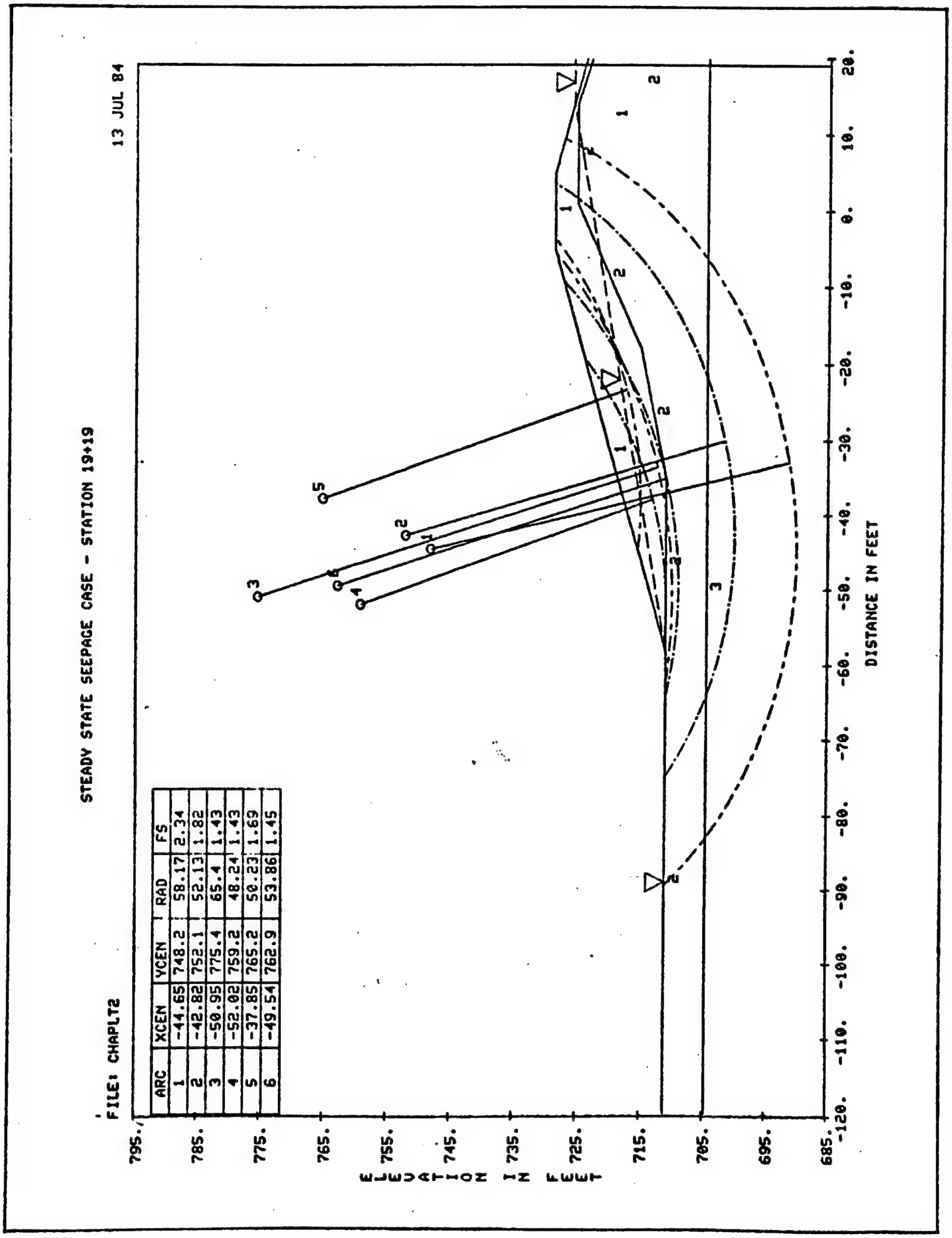
FILE: CHASPLT 12 JUL 84

SLICE	SLICE WIDTH	SLICE COORD	SLICE WT	WATER FORCE	DIREC TION	DEVEL C-FORCE	DIREC TION	PHI DEVEL	NORM STRESS	NORM FORCE	ALPHA TOP	ALPHA BOT	E1	E2
1	.67	11.71	.06	0.	0.	.22	60.35	.73	.02	.03	0.	0.	0.	0.
2	3.19	9.78	1.91	.35	108.2	1.49	56.85	7.52	.18	1.04	0.	0.	0.	0.
3	3.19	6.59	4.31	1.06	108.2	1.31	51.68	7.52	.61	3.14	0.	0.	0.	1.73
4	4.	3.	8.01	2.11	108.2	1.48	46.49	7.52	1.08	6.28	0.	0.	1.73	5.35
5	3.	-.5	7.4	2.03	108.2	1.03	41.87	7.52	1.43	5.75	0.	0.	5.35	8.49
6	3.	-3.5	8.4	2.33	108.2	.97	38.16	7.52	1.17	4.44	0.	9.14	8.49	10.87
7	3.34	-6.67	10.13	2.87	108.2	1.03	34.43	7.52	1.17	4.74	9.14	18.27	10.87	13.63
8	4.83	-10.75	15.36	4.55	108.2	0.	29.87	10.43	1.77	9.87	18.27	18.27	13.63	18.65
9	4.83	-15.58	15.77	4.84	108.2	0.	24.72	10.43	1.88	9.99	18.27	18.27	18.65	22.87
10	4.25	-20.13	13.99	4.31	103.2	0.	20.07	10.43	1.98	8.94	18.27	18.27	22.87	25.52
11	4.25	-24.38	13.93	4.41	103.2	0.	15.84	10.43	2.02	8.91	18.27	18.27	25.52	27.48
12	4.25	-28.63	13.69	4.43	103.2	0.	11.69	10.43	2.04	8.84	18.27	18.27	27.48	28.76
13	4.25	-32.88	13.28	4.35	103.2	0.	7.61	10.43	2.03	8.72	18.27	18.27	28.76	29.35
14	2.94	-36.47	8.88	2.91	90.	0.	4.19	10.43	2.08	6.13	18.27	18.27	29.35	28.63
15	2.94	-39.42	8.58	2.94	90.	0.	1.39	10.43	2.01	5.93	18.27	18.27	28.63	27.64
16	4.28	-43.03	11.83	4.26	90.	0.	-2.03	10.43	1.92	8.22	18.27	18.27	27.64	25.74
17	4.28	-47.31	10.91	4.18	90.	0.	-6.09	10.43	1.78	7.65	18.27	18.27	25.74	23.41
18	4.28	-51.58	9.82	4.02	90.	0.	-10.18	10.43	1.6	6.96	18.27	18.27	23.41	20.78
19	4.28	-55.86	8.56	3.77	90.	0.	-14.32	10.43	2.15	9.51	18.27	9.14	20.78	15.89
20	3.86	-59.93	6.79	3.11	90.	0.	-18.34	10.43	1.71	6.95	9.14	0.	15.89	12.28
21	3.86	-63.79	6.07	2.77	90.	0.	-22.23	10.43	.92	3.86	0.	0.	12.28	10.17
22	3.86	-67.65	5.2	2.35	90.	0.	-26.24	10.43	.81	3.49	0.	0.	10.17	8.05
23	3.86	-71.51	4.16	1.85	90.	0.	-30.4	10.43	.67	3.	0.	0.	8.05	6.05
24	3.28	-75.08	2.52	1.11	90.	1.01	-34.4	7.52	.67	2.65	0.	0.	6.05	3.43
25	3.28	-78.36	1.4	.61	90.	1.06	-38.25	7.52	.49	2.05	0.	0.	3.43	1.12
26	1.89	-80.94	.23	.1	90.	.64	-41.44	7.52	.33	.83	0.	0.	1.12	0.

ALL FORCES IN KIPS

ALL ANGLES MEASURED FROM POSITIVE X-AXIS

Figure B-9



STEADY STATE SEEPAGE CASE - STATION 19+19
13 JUL 84
FILE: CHAPLT2
ARC XCEN YCEN RAD FS
1 -44.65 748.2 58.17 2.34
2 -42.82 752.1 52.13 1.82
3 -50.95 775.4 65.4 1.43
4 -52.02 759.2 48.24 1.43
5 -37.85 765.2 50.23 1.69
6 -49.54 762.9 53.86 1.45
DISTANCE IN FEET
ELEVATION IN FEET

Figure B-10

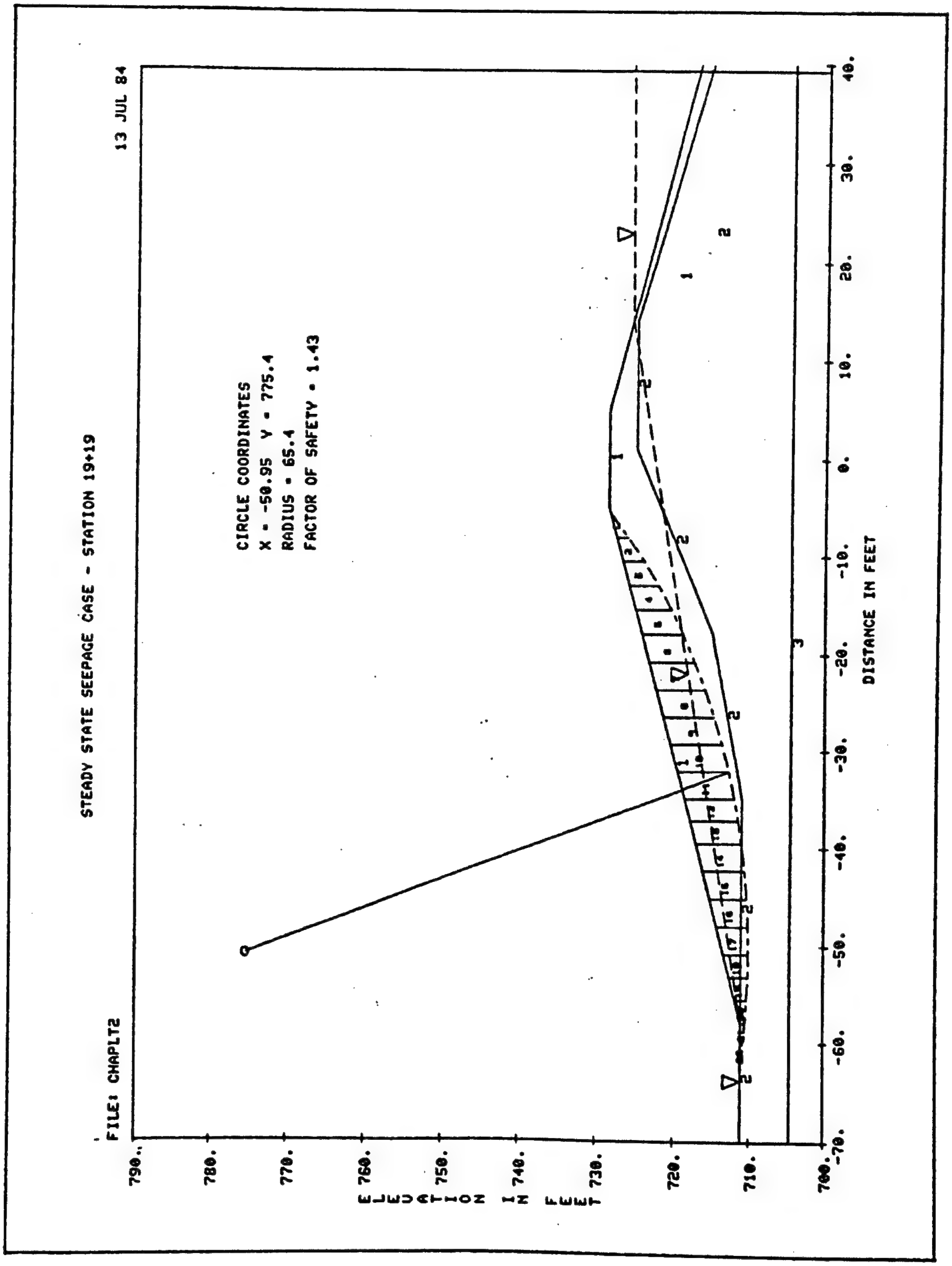

STEADY STATE SEEPAGE CASE - STATION 19+19
13 JUL 84
FILE: CHAPLT2
CIRCLE COORDINATES
X = -50.95 Y = 775.4
RADIUS = 65.4
FACTOR OF SAFETY = 1.43
ELEVATION IN FEET
DISTANCE IN FEET

Figure B-11

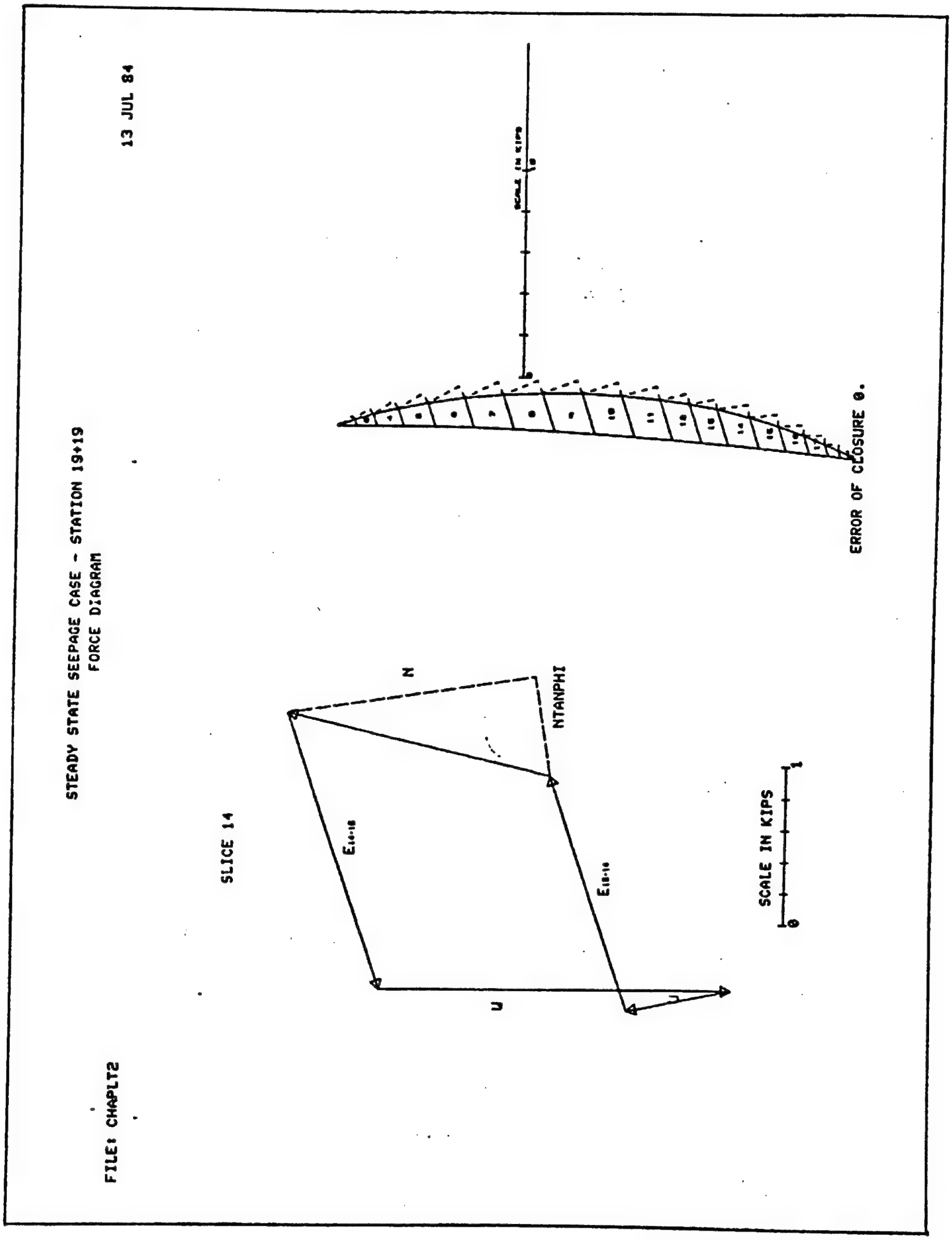

STEADY STATE SEEPAGE CASE - STATION 19+19
FORCE DIAGRAM
13 JUL 84
ERROR OF CLOSURE 0.
SLICE 14
N
NTANPHI
U
SCALE IN KIPS
0
1
FILE: CHAPLT2

Figure B-12

STEADY STATE SEEPAGE CASE - STATION 19+19
TABULATION OF SLICE DATA

FILE: CHAPLT2 13 JUL 84

SLICE	SLICE WIDTH	SLICE COORD	SLICE WT	WATER FORCE	DIREC TION	DEVEL C-FORCE	DIREC TION	PHI DEVEL	NORM STRESS	NORM FORCE	ALPHA TOP	ALPHA BOT	E1	E2
1	2.49	-6.81	.23	0.	0.	0.	42.45	20.41	.06	.21	18.27	18.27	0.	.09
2	2.49	-9.29	.65	0.	0.	0.	39.57	20.41	.18	.57	18.27	18.27	.09	.3
3	2.49	-11.78	.59	0.	0.	0.	36.79	20.41	.29	.89	18.27	18.27	.3	.58
4	2.49	-14.27	1.29	0.	0.	0.	34.12	20.41	.38	1.15	18.27	18.27	.58	.89
5	2.49	-16.76	1.53	0.	0.	0.	31.52	20.41	.47	1.37	18.27	18.27	.89	1.18
6	2.83	-19.42	2.	.12	101.4	0.	28.83	20.41	.52	1.69	18.27	18.27	1.18	1.49
7	2.83	-22.25	2.21	.28	101.4	0.	26.03	20.41	.55	1.75	18.27	18.27	1.49	1.74
8	2.83	-25.08	2.36	.41	101.4	0.	23.3	20.41	.58	1.78	18.27	18.27	1.74	1.92
9	2.83	-27.92	2.45	.52	101.4	0.	20.62	20.41	.59	1.79	18.27	18.27	1.92	2.04
10	2.83	-30.75	2.49	.59	101.4	0.	17.99	20.41	.6	1.78	18.27	18.27	2.04	2.08
11	2.83	-33.58	2.47	.64	101.4	0.	15.4	20.41	.59	1.74	18.27	18.27	2.08	2.04
12	2.28	-36.14	1.93	.54	101.4	0.	13.09	20.41	.58	1.35	18.27	18.27	2.04	1.96
13	2.28	-38.42	1.86	.54	101.4	0.	11.05	20.41	.56	1.3	18.27	18.27	1.96	1.83
14	2.85	-40.98	2.18	.66	101.4	0.	8.77	22.01	.53	1.54	18.27	18.27	1.83	1.57
15	2.85	-43.83	1.99	.63	101.4	0.	6.25	22.01	.49	1.41	18.27	18.27	1.57	1.27
16	2.85	-46.68	1.74	.57	101.4	0.	3.75	22.01	.44	1.25	18.27	18.27	1.27	.94
17	2.85	-49.53	1.44	.49	101.4	0.	1.25	22.01	.37	1.05	18.27	18.27	.94	.62
18	2.35	-52.13	.93	.32	101.4	0.	-1.03	22.01	.29	.69	18.27	18.27	.62	.38
19	2.35	-54.48	.66	.24	101.4	0.	-3.09	22.01	.21	.49	18.27	18.27	.38	.19
20	2.35	-56.83	.36	.15	101.4	0.	-5.15	22.01	.12	.28	18.27	9.14	.19	.07
21	2.17	-59.09	.15	.07	90.	0.	-7.15	22.01	.05	.1	9.14	0.	.07	.02
22	2.17	-61.26	.06	.02	90.	0.	-9.07	22.01	.02	.03	0.	0.	.02	0.

ALL FORCES IN KIPS
ALL ANGLES MEASURED FROM POSITIVE X-AXIS

Figure B-13

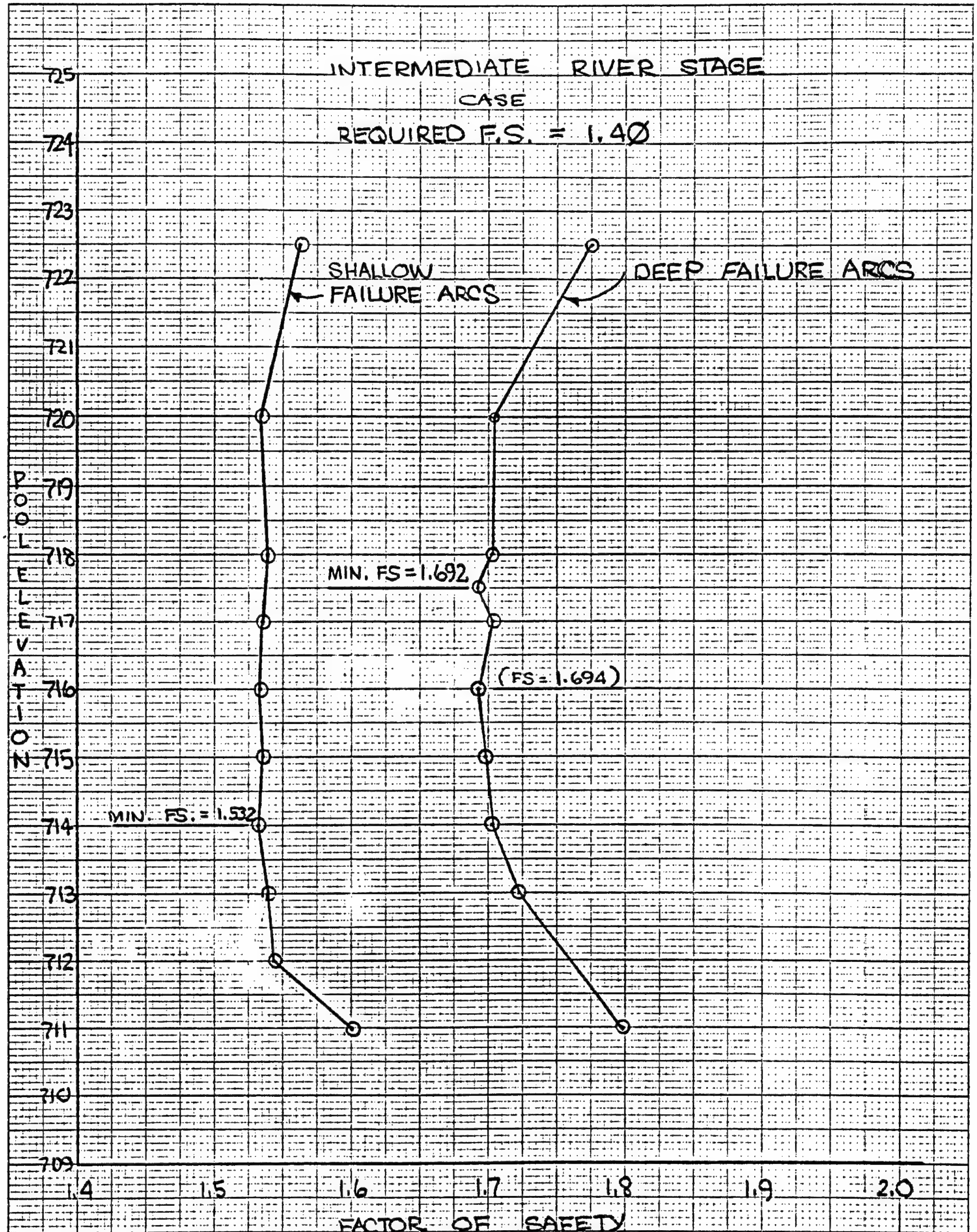
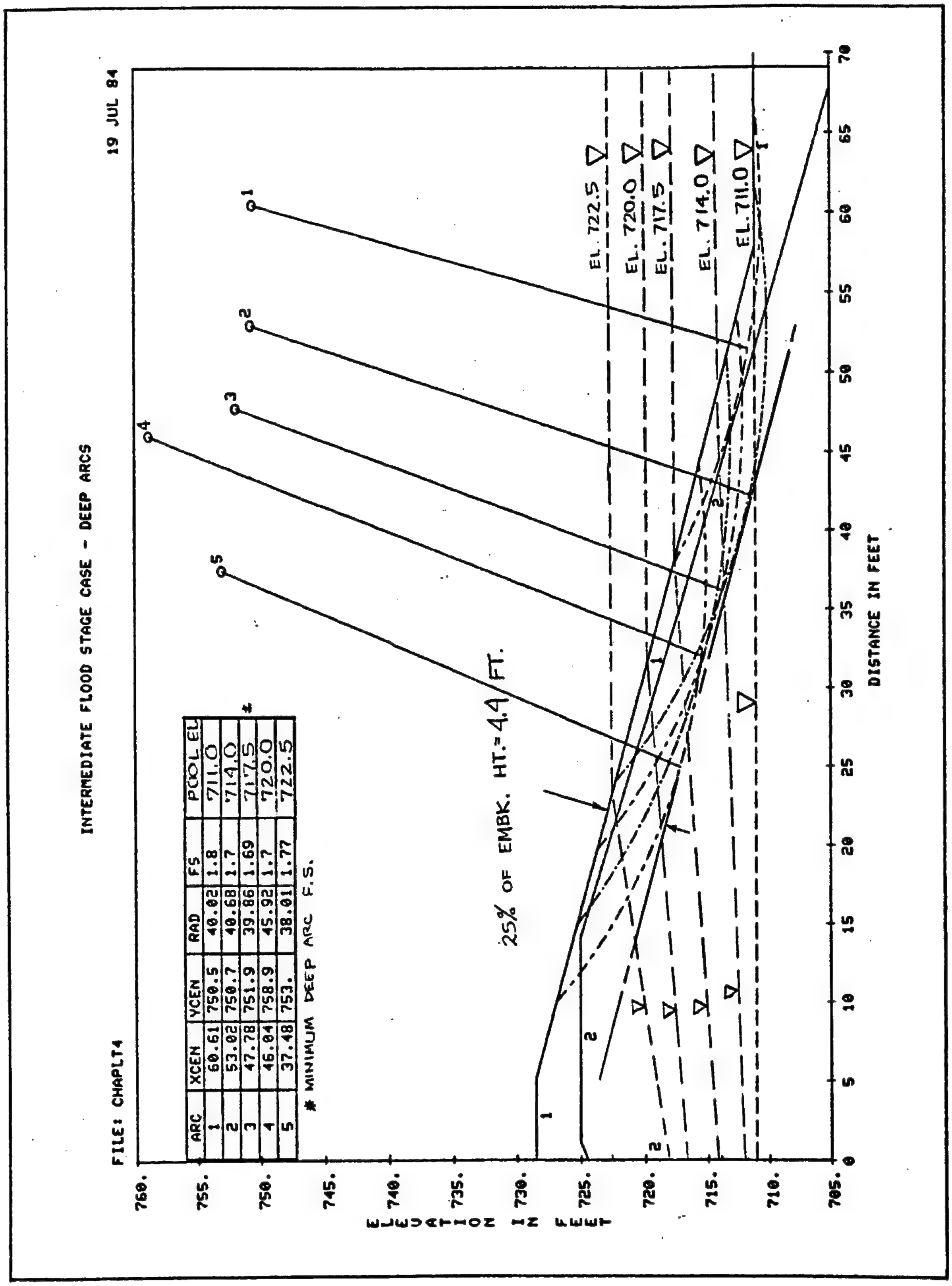


Figure B-14

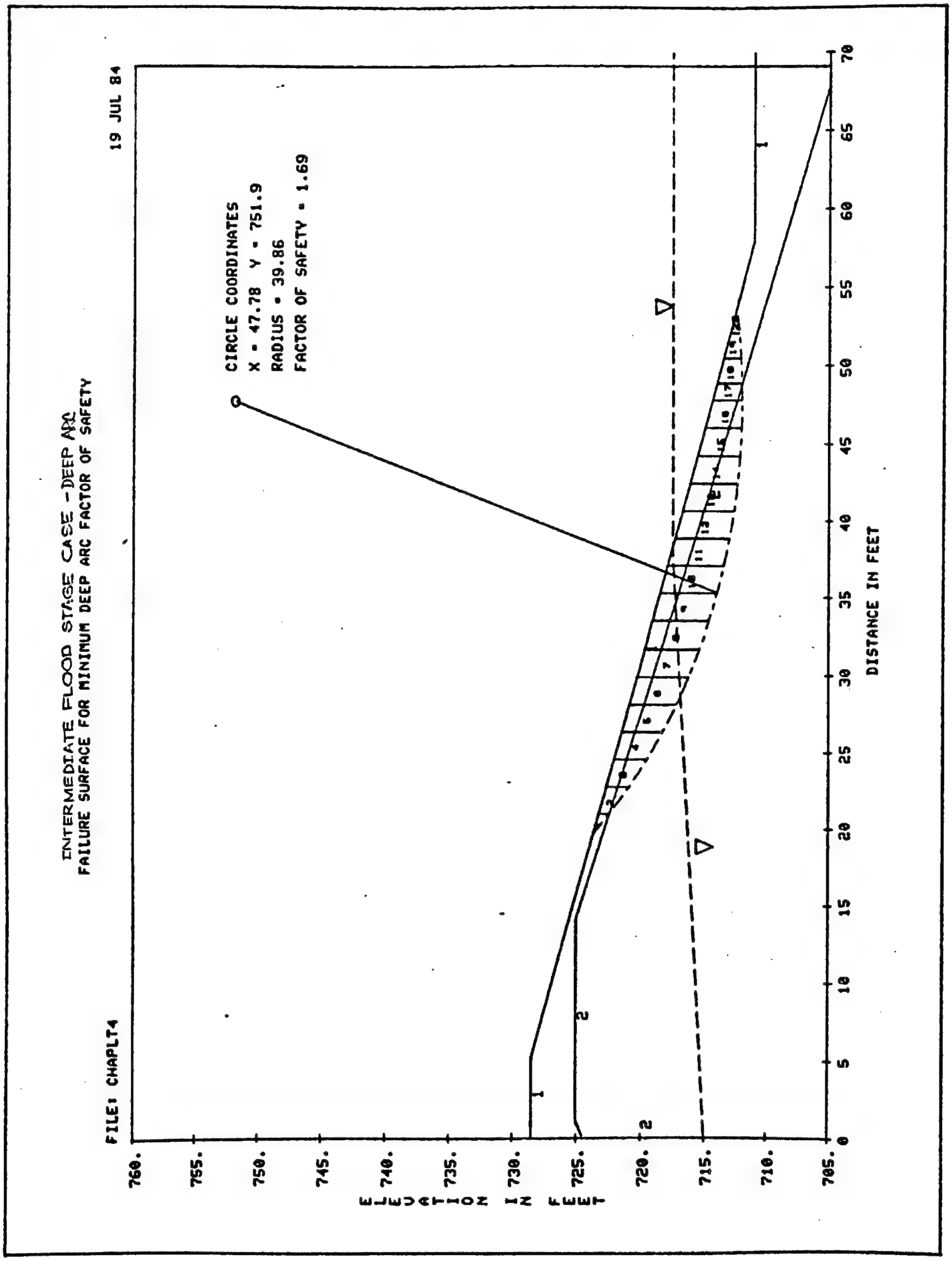
18 JULY 1984
LHB



ARC	XCEN	YCEN	RAD	FS	POOL EL
1	60.61	750.5	40.02	1.8	711.0
2	53.02	750.7	40.68	1.7	714.0
3	47.78	751.9	39.86	1.69	717.5 #
4	46.04	758.9	45.92	1.7	720.0
5	37.48	753.	38.01	1.77	722.5

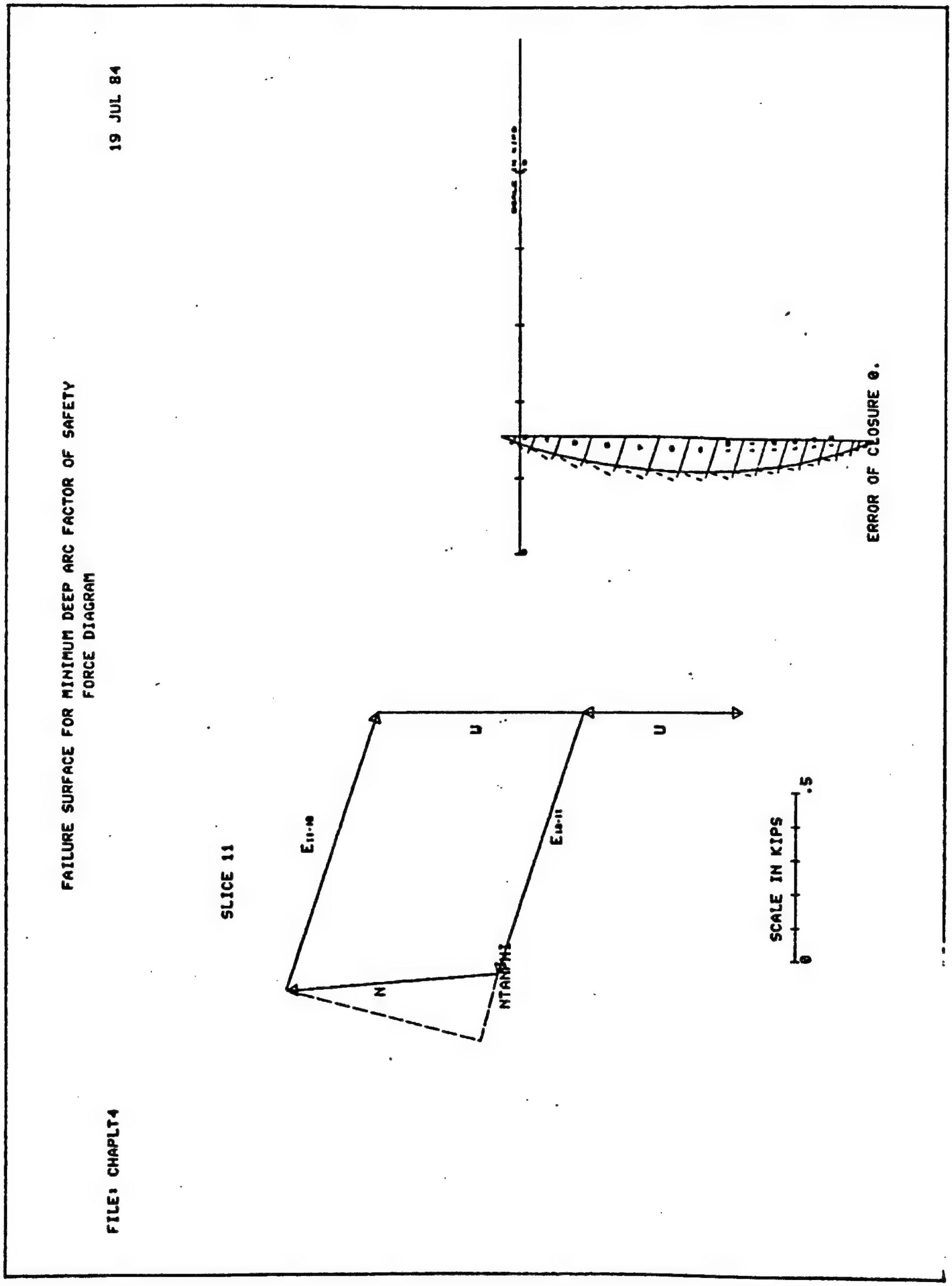
MINIMUM DEEP ARC F.S.

Figure B-15



FILE: CHAPLT4
INTERMEDIATE FLOOD STAGE CASE -DEEP ARC
FAILURE SURFACE FOR MINIMUM DEEP ARC FACTOR OF SAFETY
19 JUL 84
CIRCLE COORDINATES
X = 47.78 Y = 751.9
RADIUS = 39.86
FACTOR OF SAFETY = 1.69
ELEVATION IN FEET
DISTANCE IN FEET

Figure B-16



FAILURE SURFACE FOR MINIMUM DEEP ARC FACTOR OF SAFETY
FORCE DIAGRAM
19 JUL 84
SLICE 11
U
U
N
NTANPHI
SCALE IN KIPS
0
.5
ERROR OF CLOSURE 0.
FILE: CHAPLT4

Figure B-17

FAILURE SURFACE FOR MINIMUM DEEP ARC FACTOR OF SAFETY
TABULATION OF SLICE DATA

FILE: CHAPLT4

19 JUL 84

SLICE	SLICE WIDTH	SLICE COORD	SLICE WT	WATER FORCE	DIREC TION	DEVEL C-FORCE	DIREC TION	PHI DEVEL	NORM STRESS	NORM FORCE	ALPHA TOP	ALPHA BOT	E1	E2
1	1.31	20.24	.07	0.	0.	0.	-43.7	17.45	.03	.06	-18.27	-18.27	0.	.03
2	1.79	21.79	.3	0.	0.	0.	-40.69	18.84	.12	.27	-18.27	-18.27	.03	.14
3	1.79	23.59	.51	0.	0.	0.	-37.37	18.84	.2	.46	-18.27	-18.27	.14	.31
4	1.79	25.38	.68	0.	0.	0.	-34.19	18.84	.28	.62	-18.27	-18.27	.31	.49
5	1.79	27.17	.82	0.	0.	0.	-31.13	18.84	.35	.74	-18.27	-18.27	.49	.66
6	1.79	28.96	.92	.02	93.89	0.	-28.17	18.84	.4	.82	-18.27	-18.27	.66	.81
7	1.79	30.75	1.01	.14	93.89	0.	-25.29	18.84	.41	.8	-18.27	-18.27	.81	.9
8	1.79	32.55	1.06	.24	93.89	0.	-22.47	18.84	.4	.77	-18.27	-18.27	.9	.94
9	1.79	34.34	1.09	.33	93.89	0.	-19.71	18.84	.38	.73	-18.27	-18.27	.94	.93
10	1.79	36.13	1.11	.41	93.89	0.	-16.99	18.84	.36	.67	-18.27	-18.27	.93	.87
11	1.79	37.92	1.1	.48	90.	0.	-14.32	18.84	.33	.6	-18.27	-18.27	.87	.82
12	1.79	39.72	1.05	.47	90.	0.	-11.67	18.84	.32	.58	-18.27	-18.27	.82	.74
13	1.79	41.51	.98	.44	90.	0.	-9.05	18.84	.3	.55	-18.27	-18.27	.74	.64
14	1.79	43.3	.89	.4	90.	0.	-6.45	18.84	.28	.51	-18.27	-18.27	.64	.51
15	1.79	45.09	.78	.35	90.	0.	-3.87	18.84	.26	.46	-18.27	-18.27	.51	.38
16	1.79	46.88	.65	.3	90.	0.	-1.29	18.84	.22	.39	-18.27	-18.27	.38	.25
17	1.06	48.31	.32	.15	90.	0.	.76	18.84	.18	.19	-18.27	-18.27	.25	.18
18	1.6	49.64	.37	.17	90.	0.	2.68	17.45	.14	.23	-18.27	-18.27	.18	.09
19	1.6	51.25	.23	.11	90.	0.	4.99	17.45	.09	.15	-18.27	-18.27	.09	.03
20	1.6	52.85	.08	.04	90.	0.	7.31	17.45	.03	.05	-18.27	-18.27	.03	0.

ALL FORCES IN KIPS
ALL ANGLES MEASURED FROM POSITIVE X-AXIS

Figure B-18

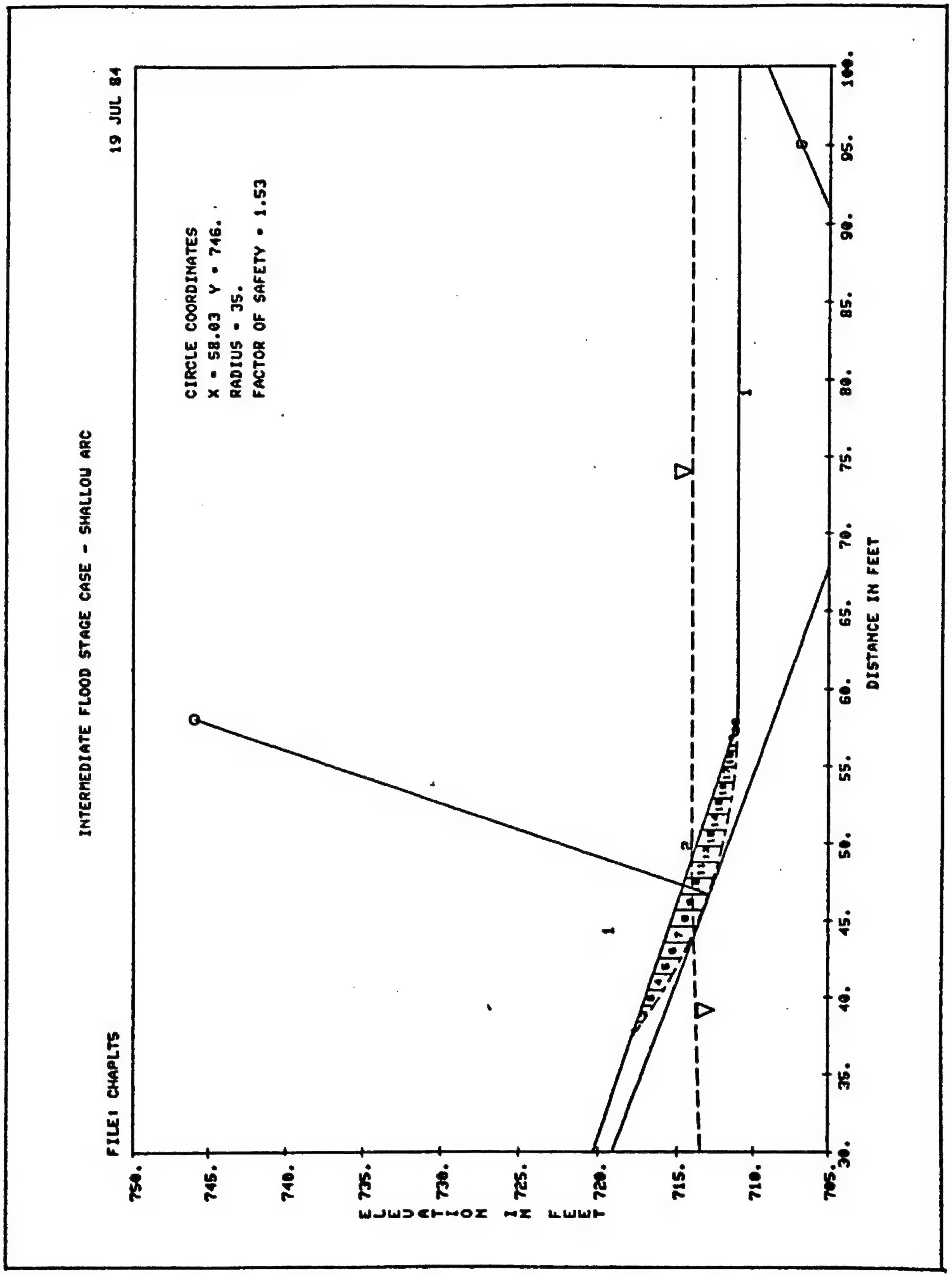

INTERMEDIATE FLOOD STAGE CASE - SHALLOW ARC
FILE: CHAPLTS
19 JUL 84
CIRCLE COORDINATES
X = 58.03 Y = 746.
RADIUS = 35.
FACTOR OF SAFETY = 1.53
DISTANCE IN FEET
ELEVATION IN FEET

Figure B-19

INTERMEDIATE FLOOD STAGE CASE - SHALLOW ARC
TABULATION OF SLICE DATA

FILE: CHAPLTS 19 JUL 84

SLICE	SLICE WIDTH	SLICE COORD	SLICE WT	WATER FORCE	DIREC TION	DEVEL C-FORCE	DIREC TION	PHI DEVEL	NORM STRESS	NORM FORCE	ALPHA TOP	ALPHA BOT	E1	E2
1	1.04	37.74	.03	0.	0.	0.	-35.44	19.14	.02	.02	-18.27	-18.27	0.	.01
2	1.04	38.78	.07	0.	0.	0.	-33.38	19.14	.05	.07	-18.27	-18.27	.01	.03
3	1.04	39.82	.11	0.	0.	0.	-31.36	19.14	.08	.1	-18.27	-18.27	.03	.05
4	1.04	40.86	.15	0.	0.	0.	-29.39	19.14	.11	.13	-18.27	-18.27	.05	.08
5	1.04	41.9	.18	0.	0.	0.	-27.46	19.14	.14	.16	-18.27	-18.27	.08	.1
6	1.04	42.93	.2	0.	0.	0.	-25.56	19.14	.16	.18	-18.27	-18.27	.1	.13
7	1.04	43.97	.22	0.	0.	0.	-23.69	19.14	.18	.2	-18.27	-18.27	.13	.14
8	1.04	45.01	.23	.03	91.62	0.	-21.84	19.14	.17	.19	-18.27	-18.27	.14	.15
9	1.04	46.05	.24	.05	91.62	0.	-20.02	19.14	.16	.18	-18.27	-18.27	.15	.15
10	1.04	47.09	.25	.08	91.62	0.	-18.22	19.14	.15	.16	-18.27	-18.27	.15	.15
11	1.04	48.13	.25	.1	90.	0.	-16.44	19.14	.13	.15	-18.27	-18.27	.15	.14
12	1.04	49.17	.25	.12	90.	0.	-14.67	19.14	.12	.13	-18.27	-18.27	.14	.13
13	1.04	50.21	.24	.11	90.	0.	-12.92	19.14	.12	.13	-18.27	-18.27	.13	.11
14	1.04	51.25	.22	.1	90.	0.	-11.18	19.14	.11	.12	-18.27	-18.27	.11	.1
15	1.04	52.29	.2	.09	90.	0.	-9.45	19.14	.1	.11	-18.27	-18.27	.1	.08
16	1.04	53.32	.17	.08	90.	0.	-7.73	19.14	.09	.1	-18.27	-18.27	.08	.06
17	1.04	54.36	.14	.07	90.	0.	-6.02	19.14	.08	.08	-18.27	-18.27	.06	.03
18	1.04	55.4	.11	.05	90.	0.	-4.31	19.14	.06	.06	-18.27	-18.27	.03	.02
19	1.04	56.44	.07	.03	90.	0.	-2.61	19.14	.04	.04	-18.27	-18.27	.02	0.
20	1.04	57.48	.02	.01	90.	0.	-.91	19.14	.01	.01	-18.27	-18.27	0.	0.

ALL FORCES IN KIPS
ALL ANGLES MEASURED FROM POSITIVE X-AXIS

Figure B-20

BORING EVALUATION SHEET

PROJECT: CHASKA - MN RIVER LEVEE

BORING NO. : 82-37M, 39M, 73-4M

DATE: JAN 84

FOR BORINGS SEE SECTION

BLANKET

ELEV. TOP OF FLOOD BARRIER: 789.0

SOIL UNIT	TOP ELEV.	(1) $K_v x10^4$	γ_m	Z_i	(6) F_t	Z_b	Z_t	ΣZ_b	ΣZ_t	(5) ΣWT.	$\Sigma \frac{WT.}{\gamma_w}$
SM-ML	720	16	53.5	8.5	.5	4.25	8.5	8.25	12.5	704.8	11.3
CL	711.5	8	62.5	4.0	1	4.0	4.0	4.0	4.0	250.0	4.0

MINIMUM $K_v \times 10^4$ = 8 FPM

(1) SEE PAGE 265 T.M. 3-424 (2) SEE PAGE 44 T.M. 3-424
(3) G= GRADATION, P=PERMEABILITY TEST, A=ASSUMED VALUES
(4) SEE PAGE 51 T.M. 3-424 (5) WT.= $Z_t * \gamma'_m$ (6) F_t=TRANS.FACTOR

PERVIOUS ZONE

SOIL UNIT	TOP ELEV.	d	D_{10}	(4) SOURCE	(3) K_h	$\Sigma K_h * d$	$D=\Sigma d$
SP	707.5	5.0	0.11	A	.052	0.26	5.0
OL	702.5	4.5	—	—	—	—	—
SP	697	2.5	0.11	A	.052	0.13	7.5
SP	694.5	6.0	0.09	A	.027	0.162	13.5
SP	688.5	13.5	0.11	A	.052	0.702	27.0
	675	—	—	—			
						1.254	

K_f= 0.046 FPM, c= 0.0088, X_3= 113.2 FT

SUMMARY COMPUTATIONS

Z_t-TOP ELEV.	H	S	X_3	H_0	X	H_x	$\Sigma \frac{WT.}{\gamma_w}$	F.S.
720.0	19	126.5	113.2	4.25	0	4.25	11.3	2.66

Figure B-21

V. scale 1" =

$L_1 = 62'$ $X_1 = \frac{\tanh(0.0088)(62)}{0.0088} = 56.5'$ $L_2 = 70'$ $S = 56.5 + 70 = 126.5$

$H = 9'$

$\phi = \frac{27}{126.5 + 113.2} = 0.113$ $h_o = 9\left(\frac{113.2}{126.5 + 113.2}\right) = 4.25'$

$Q_S = 0.113(0.044)(.61)\left(7.48\ \frac{GPM}{FPM}\right) = 0.23$ GPM/FT OF LEVEE

SEEPAGE CASE 7 = SEMI-PERVIOUS BLANKET (BOTH SIDES)

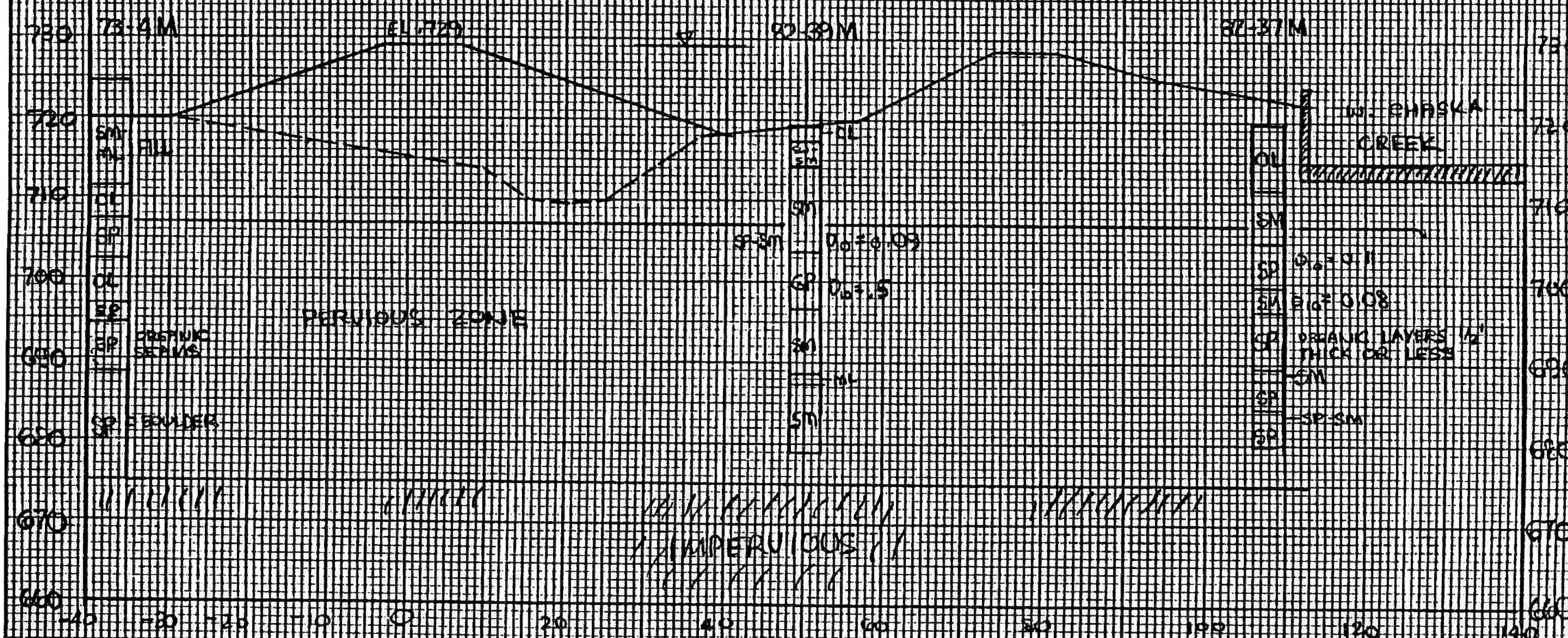


Figure B-22

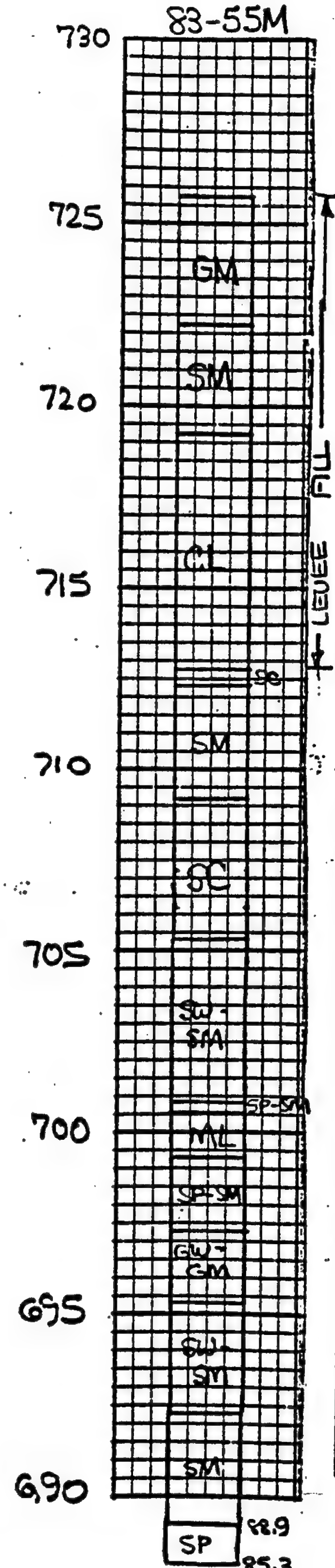
BORING EVALUATION SHEET

PROJECT: CHASKA - MN RIVER LEVEE

BORING NO. : 83-55M, 54M

DATE: JAN 84

ELEV. TOP OF FLOOD BARRIER: 728.5



V. scale 1" = 5'

BLANKET

SOIL UNIT	TOP ELEV.	K_v x10^4 (1)	γ_m	Z_i	F_t (6)	Z_b	Z_t	ΣZ_b	ΣZ_t	ΣWT. (5)	ΣWT./γ_w
SC	715	6	62.5	2.8	1	2.8	2.8	7.5	9.7	590.8	9.47
SM	712.2	20	57.5	3.1	.3	.93	3.1	4.7	6.9	415.8	6.66
SC	709.1	6	62.5	3.8	1	3.8	3.8	3.8	3.8	237.5	3.81

MINIMUM K_v x 10^4 = 6 FPM

(1) SEE PAGE 265 T.M. 3-424 (2) SEE PAGE 44 T.M. 3-424
(3) G= GRADATION, P=PERMEABILITY TEST, A=ASSUMED VALUES
(4) SEE PAGE 51 T.M. 3-424 (5) WT.= $Z_t * \gamma'_m$ (6) F_t=TRANS.FACTOR

PERVIOUS ZONE

SOIL UNIT	TOP ELEV.	d	D_{10}	(4) SOURCE	(3) K_h	ΣK_h*d	D=Σd
SW-SM	705.3	4.4	0.18	G	.16	0.704	4.4
SP-SM	700.9	0.4	0.08	A	.02	0.008	4.8
ML	700.5	1.2	—	—	—	—	4.8
SP-SM	699.3	2.0	0.09	A	.027	0.054	6.8
GW-GM	697.3	2.0	0.14	A	.092	0.184	8.8
SW-SM	695.3	3.0	0.14	A	.092	0.276	11.8
SM	692.3	3.4	—	—	—		11.8
SP	688.9	3.6	0.08	A	.02	0.072	15.4
SM	685.3		—	—	—		
						1.298	

K_f= 0.084 FPM, c= 0.0079, X_3= 127.2 FT

SUMMARY COMPUTATIONS

Z_t-TOP ELEV.	H	S	X_3	H_0	X	H_x	ΣWT./γ_w	F.S.
715	13.5	191.1	127.2	5.39	0	—	9.47	1.76

Figure B-23

ASSUMPTION - EFFECTIVE SEEPAGE ENTRY AT EDGE OF CONCRETE CHANNEL THROUGH PERVIOUS FROST LAYER AND OR WEEP HOLES. $\therefore L_1 = 105'$

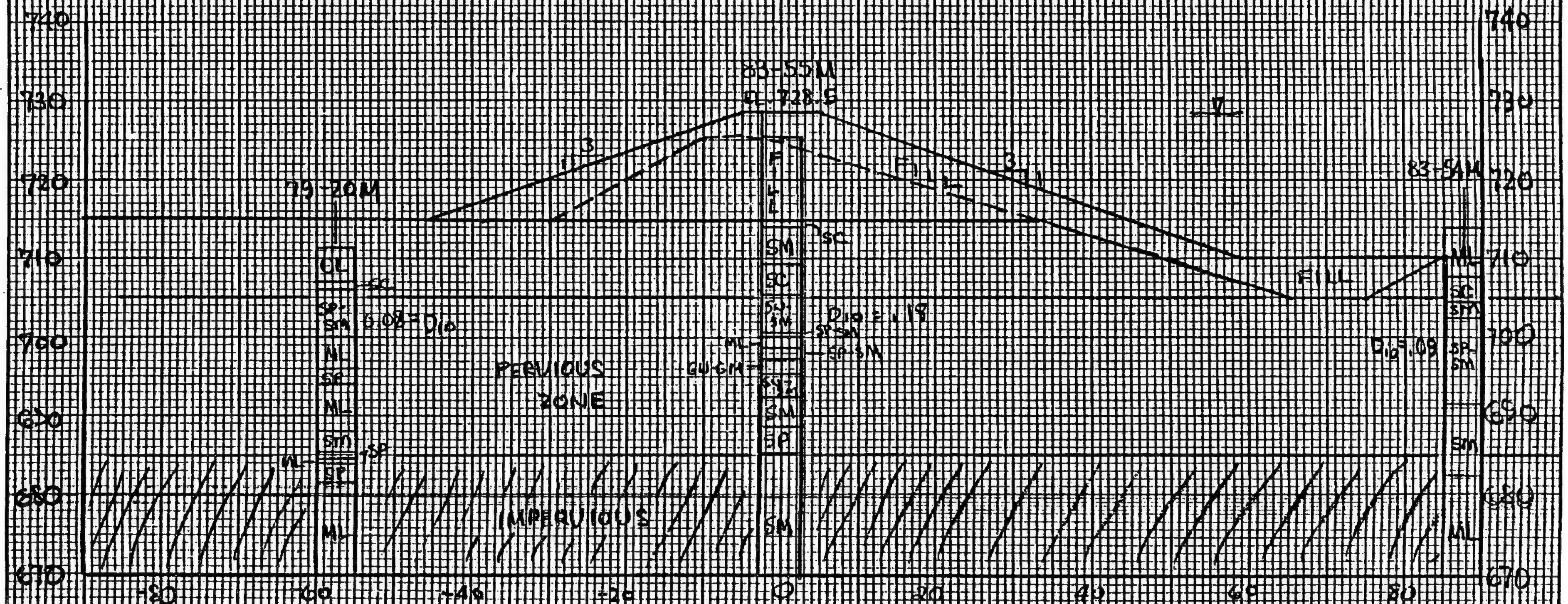
$$X_1 = \frac{\text{TANH}\,(0.0079)(105)}{.0079} = 86.1'$$

SEEPAGE CASE 7 - SEMI-PERVIOUS BLANKET (BOTH SIDES)

$L_2 = 105'$ $H = 13.5'$ $L_3 = \infty$ $X_3 = 127.2'$ $S = 86.1' + 105' = 191.1'$

$$H_0 = 13.5\left(\frac{127.2}{191.1+127.2}\right) = 5.39' \qquad i = \frac{5.4}{191.1+127.2} = 0.048$$

$$Q_s = 0.048(.084)(10.5)\left(7.48\,\frac{GPM}{CFM}\right) = 0.317 \text{ GPM/FT. OF LEVEE}$$



PAGE 2 OF 2

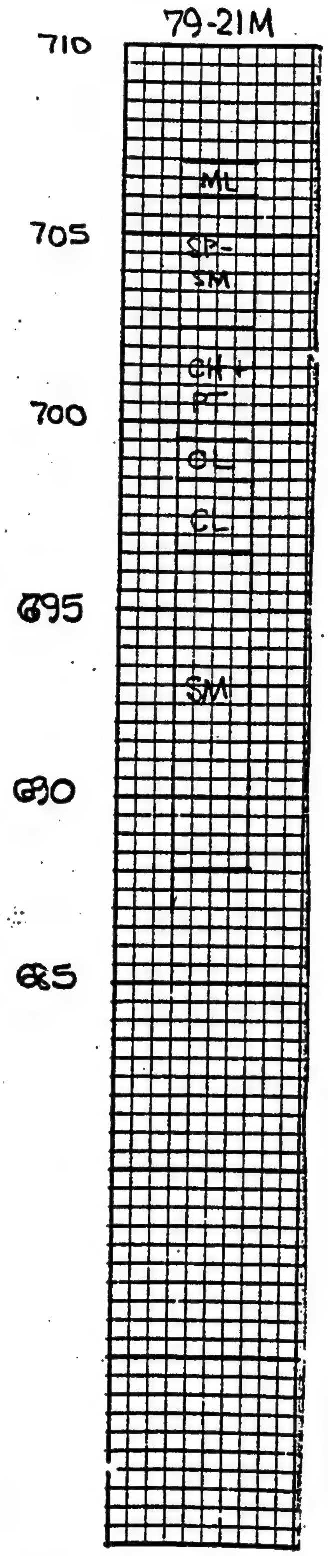
Figure B-24

BORING EVALUATION SHEET

PROJECT: CHASKA - MN RIV. LEVEE

BORING NO. : 79-21M, 20M

DATE: 18 JAN 1984



BLANKET

ELEV. TOP OF FLOOD BARRIER: 728.5

SOIL UNIT	TOP ELEV.	$K_v \times 10^4$ (1)	γ'_m	z_i	F_t (6)	z_b	z_t	Σz_b	Σz_t	$\Sigma WT.$ (5)	$\Sigma WT./\gamma_w$
CL	709.5	6	62.5	2.6	1	2.6	2.6	10.25	10.25	632	10.13
CL	710	6	62.5	3.1	1	3.1	3.1	10.75	10.75	663.3	10.63
SC	706.9	6	62.5	0.9	[illegible]	0.9	0.9	7.65	7.65	469.5	
SP-SM	706	92	67.5	3.5	0.07	0.25	0.25	6.75	6.75	413.2	
CH	702.5	6	60	2.0	1	2.0	2.0	6.5	6.5	396.3	
OL	700.5	6	60	2.0	1	2.0	2.0	4.5	4.5	276.3	[illegible]
CL	698.5	6	62.5	2.5	1	2.5	2.5	2.5	2.5	156.3	[illegible]

MINIMUM $K_v \times 10^4$ = 6 FPM

(1) SEE PAGE 265 T.M. 3-424 (2) SEE PAGE 44 T.M. 3-424
(3) G= GRADATION, P=PERMEABILITY TEST, A=ASSUMED VALUES
(4) SEE PAGE 51 T.M. 3-424 (5) WT.= $Z_t * \gamma'_m$ (6) F_t=TRANS.FACTOR

PERVIOUS ZONE

SOIL UNIT	TOP ELEV.	d	D_{10}	SOURCE (4)	K_h (3)	ΣK_h*d	$D=\Sigma d$
SP-SM	696	8	0.08	A	0.02	0.16	8
SP-SM	688	2	0.14	A	0.092	0.18	10
	686						

K_f= 0.034 FPM, c= 0.013, X_3= 78[illegible] FT

SUMMARY COMPUTATIONS

Z_t-TOP ELEV.	H	S	X_3	H_0	X	H_x	$\Sigma WT./\gamma_w$	F.S.
710.0	21.5	204.5	78	5.94	0	5.94'	10.63	1.79
709.5	21.5	204.5	78	5.94	30	4.02'	10.13	2.52

Figure B-25

PAGE 1 OF 2

Y. scale
1" = 5'

ASSUMPTIONS

1) UPPER SP-SM LAYER IS POSITIVELY CUT-OFF BY FILLING THE WEST CHASKA CREEK CHANNEL.

2) ASSUME SM LAYER IS REALLY SP-SM & SM MIXTURE OF LAYERS - USE AN AVERAGE PERMEABILITY FROM BORING 79-17M.

$$X_1 = \frac{\tanh[(0.013)(140')]}{0.013} = 73'$$

SEEPAGE CASE 7 - SEMI-PERVIOUS BLANKET (BOTH SIDES)

$L_1 = 140'$ $\qquad L_2 = 131.5$ FT $\qquad S = X_1 + L_2 = 73' + 131.5' = 204.5'$

$L_3 = \infty$ $\qquad H = 21.5$ FT $\qquad \delta = \frac{10}{204.5 + 78} = 0.035$

$$H_0 = 21.5\left[\frac{78}{204.5 + 78}\right] = 5.94'$$

$$H_{30} = 5.94' e^{-.013(30)} = 4.02'$$

$$Q_S = 0.035\ (0.034')(18.5')\left(7.48\ \frac{GPM}{FT^3/M}\right) = 0.165 \text{ GPM/FT OF LEVEE}$$

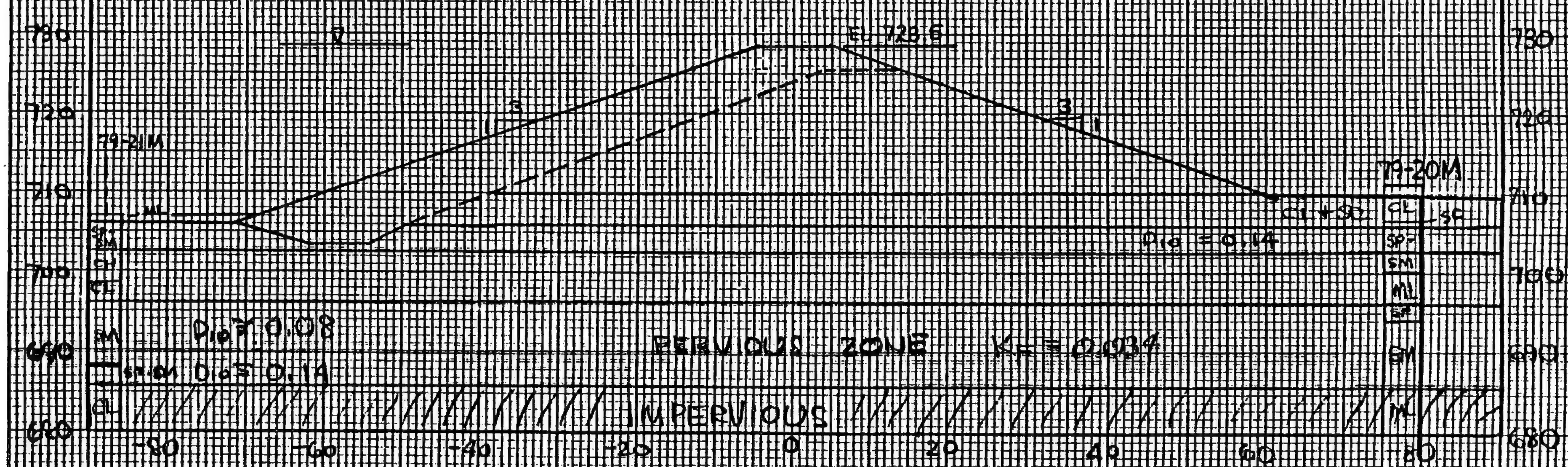
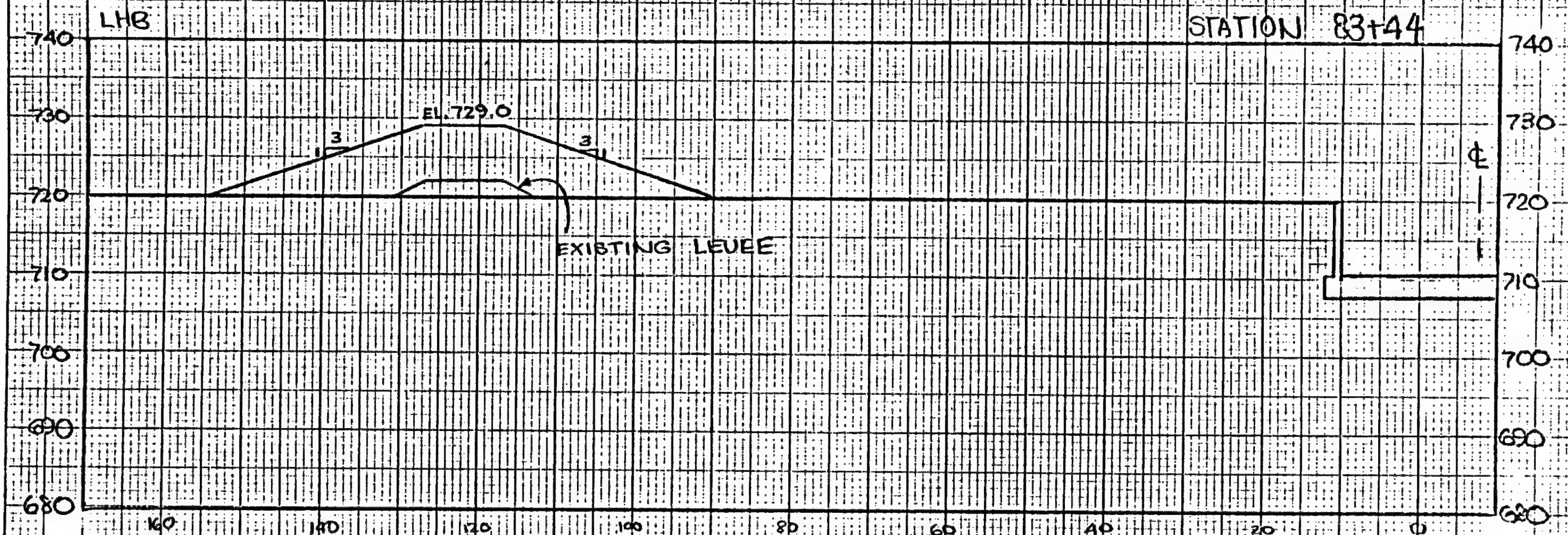


Figure B-26



QUANTITY OF FILL REMOVED BY CHANNEL EXCAVATION = 9.2' × 35' = 322 FT²
ASSUMING 120 LB./FT³ UNIT WEIGHT AND NEGLECTING THE ADDITIONAL WEIGHT OF THE CONCRETE CHANNEL OVER THE EXISTING SOIL WEIGHT YIELDS 322 FT² * 120 LB/FT³ = 38,640 LB/UNIT FOOT OF CHANNEL REMOVED OR A STRESS OF 1104 PSF / UNIT FOOT OF CHANNEL. FROM COMPUTER PROGRAM I0016 (CORPS LIBRARY) THE EXISTING LEVEE CAUSED A INCREASE IN STRESS OF 0.44 PSF. SUBTRACTING THIS VALUE FROM THE STRESS INDUCED BY THE PROPOSED PROJECT LEVEE YIELDS AN INCREASE IN STRESS OF 5.06 PSF.

NET CHANGE IN STRESS = 5.06 PSF − 1104 PSF = −1098.9 PSF
(A DECREASE OF 0.55 TSF)

Figure B-27

CHASKA LEVEE IMPROVEMENTS, CHASKA MN.
CHANGE IN STRESS AT CONCRETE CHANNEL
PROPOSED PROJECT CONDITIONS LHB

WESTERGAARD SOLUTION. IF AMU= 0.3200

VERTICAL STRESS DISTRIBUTION AT:
X COORDINATE= 7.50 Y COORDINATE= 0.00

DEPTH(Z)	ELASTIC SOLUTION VERTICAL STRESS	NORMAL LOADING VERTICAL STRESS
9.20	5.465	4.152
10.20	5.914	4.602
11.20	6.361	5.051
12.20	6.808	5.500
13.20	7.255	5.948
14.20	7.700	6.396
15.20	8.145	6.843

NUMBER OF AREAS USED IN CALCULATION= 10

NOTE: ALL Z VALUES ARE REFERENCED TO THE LOWEST PAROF THE CONFIGURATION
RUN COMPLETE
EOT..
BYE

EXISTING CONDITIONS

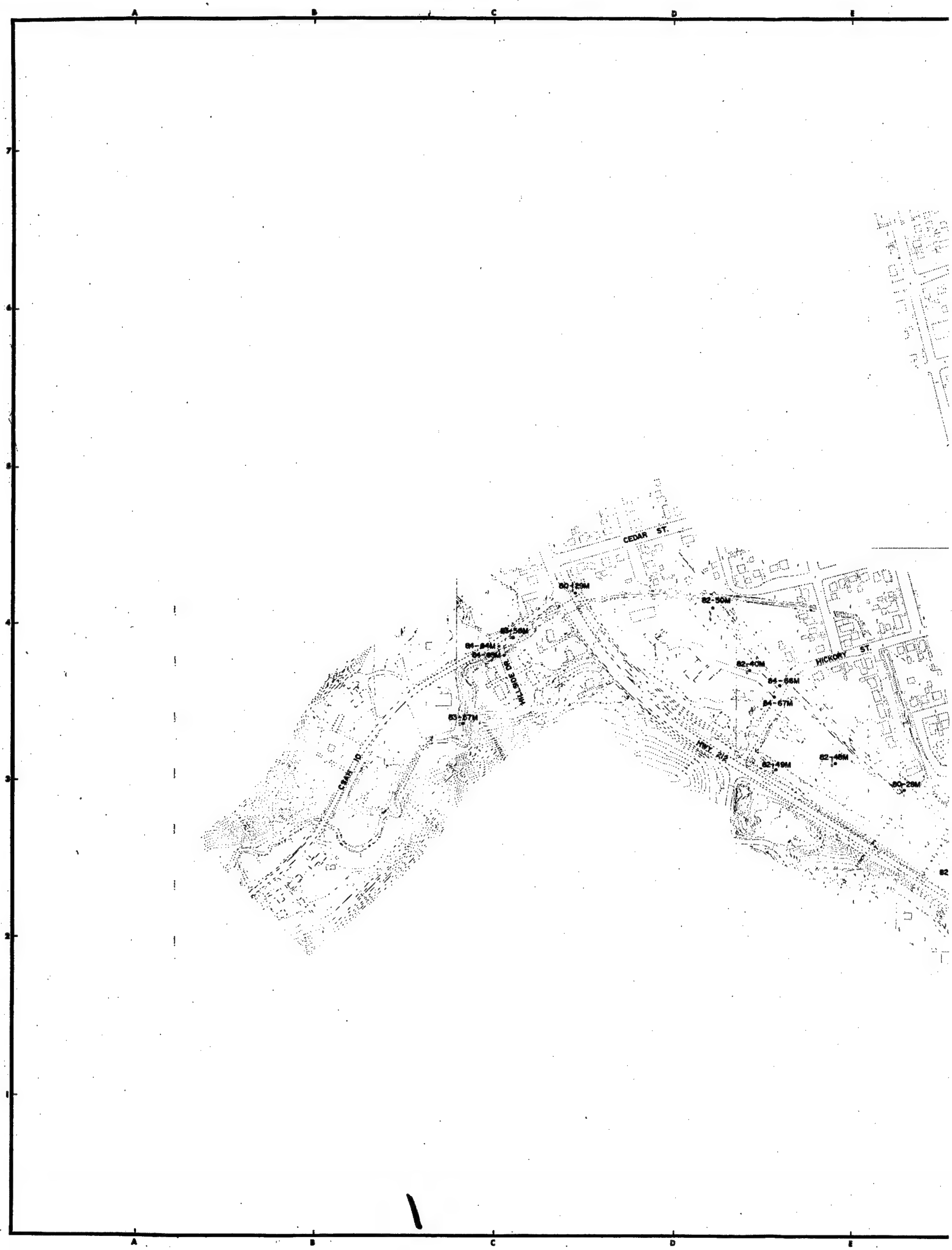
WESTERGAARD SOLUTION. IF AMU= 0.3200

VERTICAL STRESS DISTRIBUTION AT:
X COORDINATE= 7.50 Y COORDINATE= 0.00

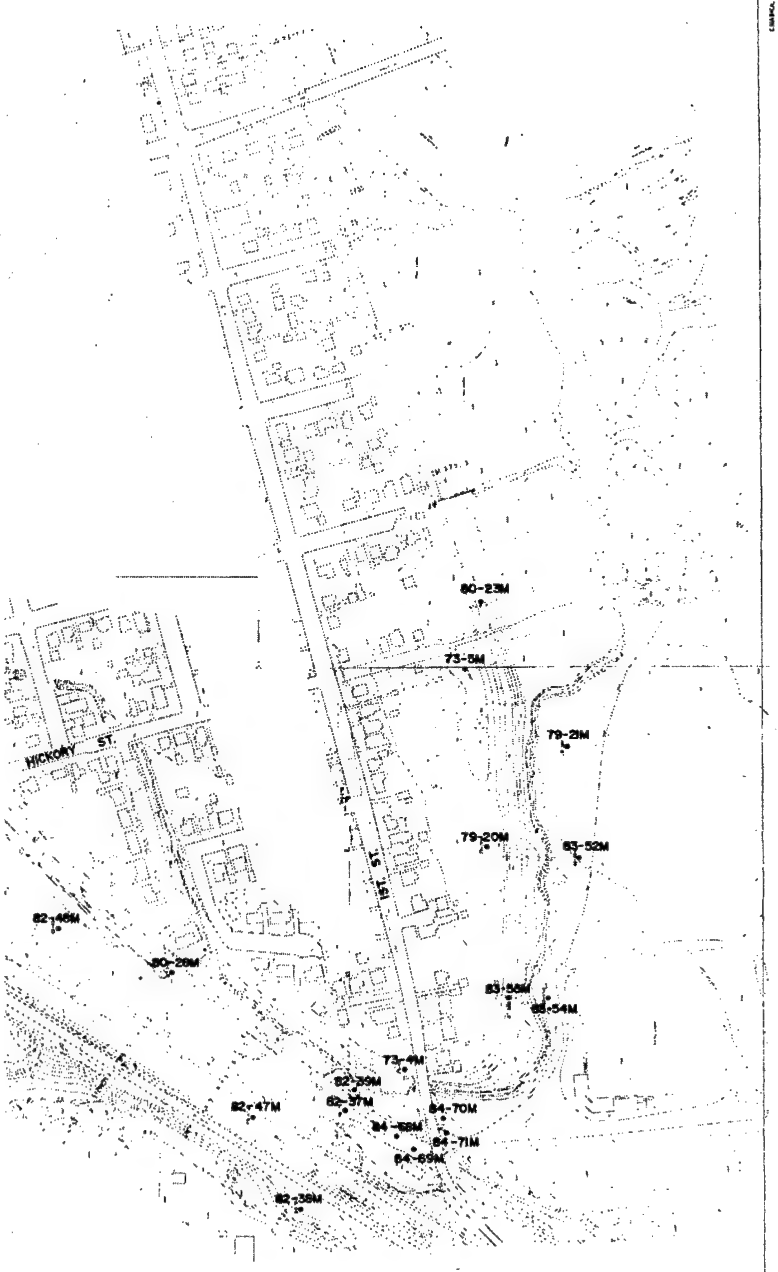
DEPTH(Z)	ELASTIC SOLUTION VERTICAL STRESS	NORMAL LOADING VERTICAL STRESS
9.20	0.357	0.332
10.20	0.393	0.368
11.20	0.429	0.404
12.20	0.465	0.440
13.20	0.501	0.476
14.20	0.537	0.511
15.20	0.572	0.547

NUMBER OF AREAS USED IN CALCULATION= 5

Figure B-28



CEDAR ST.
HICKORY ST.
HWY. 212
HILLSIDE DR.
80-29M
82-50M
83-56M
84-64M
84-65M
83-57M
82-40M
84-66M
84-67M
82-49M
82-48M
80-28M
82



BORING LOG INDEX		
PLATE NO.	DRAWING NUMBER	DESCRIPTION
B-1	M34-CH-R-5/145	BORING LOCATION & INDEX
B-2	M34-CH-R-5/146	BORING LOGS 73-4M THUR 80-29M
B-3	M34-CH-R-5/147	BORING LOGS 82-37M THUR 82-50M
B-4	M34-CH-R-5/148	BORING LOGS 83-52M THUR 83-57M
B-5	M34-CH-R-5/149	BORING LOGS 84-64M THUR 84-71M
B-6	M34-CH-R-5/151	TRIAXIAL TESTS 80-28M,82-37M,82-52M,82-55M
B-7	M34-CH-R-5/152	TRIAXIAL TESTS 83-54M & 83-55M
B-8	M34-CH-R-5/153	TRIAXIAL TEST 82-50M, CONSOLIDATION TEST 83-52M
B-9	M34-CH-R-5/154	CONSOLIDATION TESTS 82-37M & 82-50M
B-10	M34-CH-R-5/156	GRADATION CURVES 73-5M THUR 83-53M
B-11	M34-CH-R-5/157	GRADATION CURVES 83-53M THUR 83-55M

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

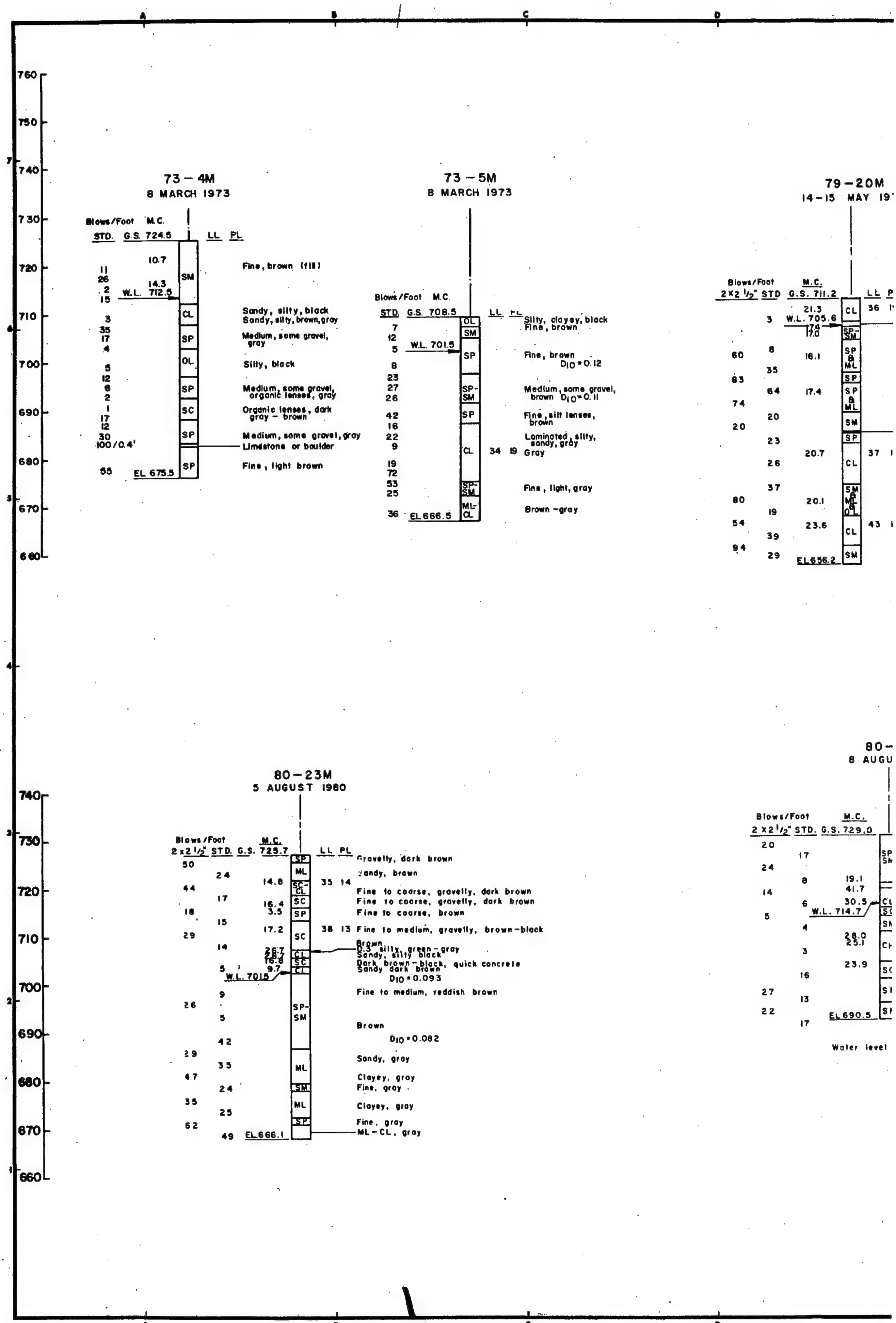
DESIGNED BY: P.D.M.
DRAWN BY: J.H.M.
CHECKED BY: P.D.M.
SUBMITTED BY: [signature] CHIEF ED-G BRANCH
APPROVED: [signature] CHIEF ENGR. DIVISION

FLOOD CONTROL FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
CHASKA CREEK
BORING LOCATION & INDEX

DATE: OCT 1984
SCALE: 1" = 200'
DRAWING NUMBER M35-CH-R-5/145
SHEET OF

SAFETY PAYS

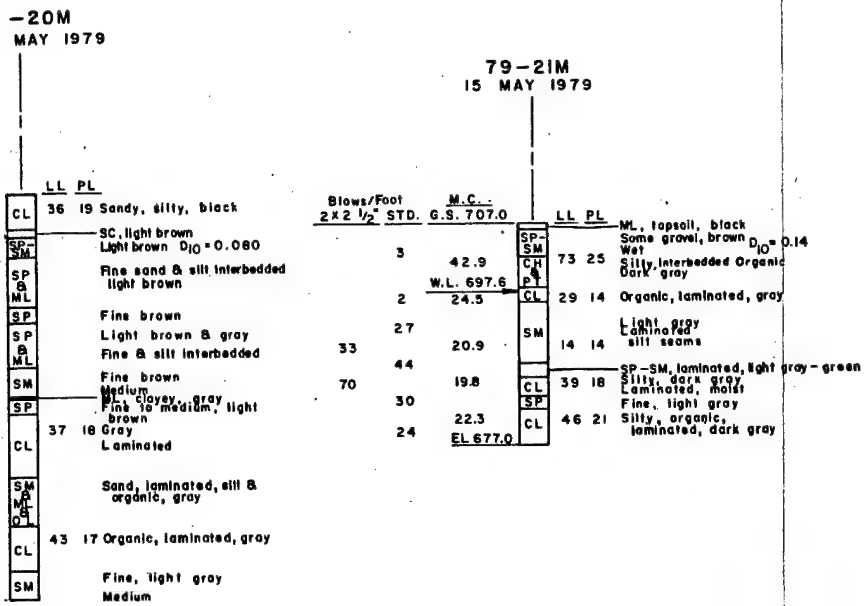
2

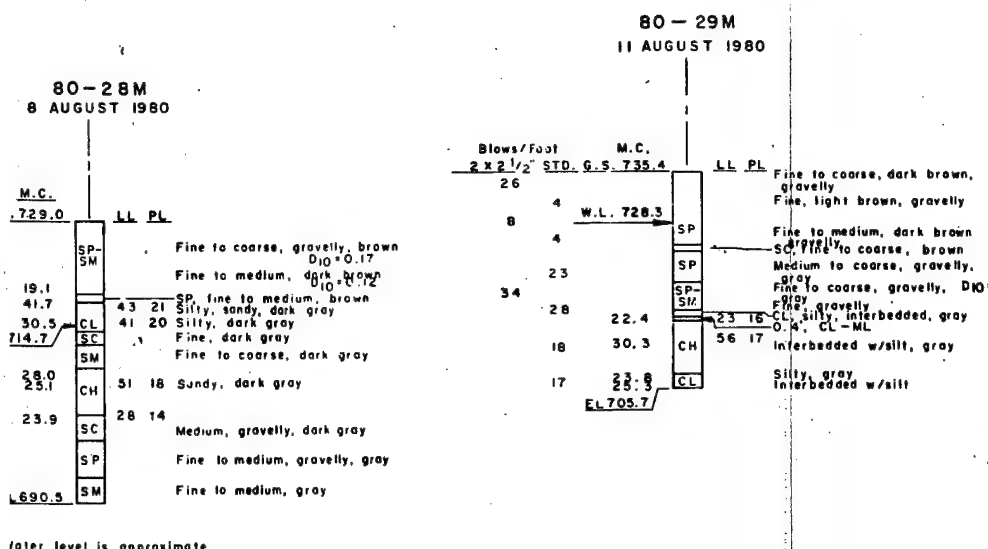


73 – 4M
8 MARCH 1973
Blows/Foot STD.
M.C.
G.S. 724.5
LL PL
W.L. 712.5
EL 675.5
Fine, brown (fill)
Sandy, silty, black
Sandy, silty, brown, gray
Medium, some gravel, gray
Silty, black
Medium, some gravel, organic lenses, gray
Organic lenses, dark gray – brown
Medium, some gravel, gray
Limestone or boulder
Fine, light brown
73 – 5M
8 MARCH 1973
Blows/Foot STD.
M.C.
G.S. 708.5
LL PL
W.L. 701.5
EL 666.5
Silty, clayey, black
Fine, brown
Fine, brown D10 = 0.12
Medium, some gravel, brown D10 = 0.11
Fine, silt lenses, brown
Laminated, silty, sandy, gray
Gray
Fine, light, gray
Brown – gray
79 – 20M
14 – 15 MAY 19
Blows/Foot 2x2 1/2" STD
M.C.
G.S. 711.2
W.L. 705.6
EL 656.2
80 – 23M
5 AUGUST 1980
Blows/Foot 2x2 1/2" STD.
M.C.
G.S. 725.7
LL PL
W.L. 701.5
EL 666.1
Gravelly, dark brown
Sandy, brown
Fine to coarse, gravelly, dark brown
Fine to coarse, gravelly, dark brown
Fine to coarse, brown
Fine to medium, gravelly, brown – black
Brown
Silty, green – gray
Sandy, silty black
Dark brown – black, quick concrete
Sandy dark brown
D10 = 0.093
Fine to medium, reddish brown
Brown
D10 = 0.082
Sandy, gray
Clayey, gray
Fine, gray
Clayey, gray
Fine, gray
ML – CL, gray
80 –
8 AUGU
Blows/Foot 2x2 1/2" STD.
M.C.
G.S. 729.0
W.L. 714.7
EL 690.5
Water level

BORING NOTES

1. General: the legend presents only the basic soils to complete the classification, pertinent information is added to the right of the boring log.
2. Dual classification: where soil is considered to be on the border line of two or more groups a double symbol is used I.E. - (GP-GM) or (CL-CM).
3. Blow count: blow counts are shown to the left of the boring logs and are the number of blows necessary to drive the sampler used a distance of 12 inches. Sampler size and penetration effort are noted on the logs. All unmarked blow counts are for a standard penetration test, using a $1\frac{3}{8}$" x 2" sampler, 140 lb hammer and 30" drop
4. Soil color: is shown as lt. (light), dk. (dark), br. (brown), gr. (gray), and bl. (black), to the right of the boring log.
5. For boring locations, see plate 5-1.
6. Elevation: all elevations shown are in feet (M.S.L.-U.S.G.S. 1912 adj.).
7. Moisture content: the natural moisture content in percent of dry weight is shown to the left of the boring log.
8. Atterberg limits: liquid limed (LL.) and plastic limit (PL.) are shown to the right of the boring log.





GW	
GP	POORLY GRADED GRAVELS LITTLE OR NO FINES
GM	
GC	CLAYEY GRAVELS, GRAVEL SAND CLAY MIXTURES
SW	WELL GRADED SAND, LITTLE OR NO FINES
SP	POORLY GRADED SANDS, LITTLE OR NO FINES
SM	SILTY SANDS
SC	CLAYEY SANDS
ML	INORGANIC SILTS, LIQUID LIMIT LESS THAN 50
CL	INORGANIC CLAYS, LOW TO MEDIUM PLASTICITY LIQUID LIMIT LESS THAN 50
MH	
CH	INORGANIC CLAYS, HIGH PLASTICITY, LIQUID LIMIT GREATER THAN 50
OL	ORGANIC SILTS OR CLAYS, LOW PLASTICITY
OH	
PT	
W.L.	WATER LEVEL AT DATE OF BORING SEE NOTE 7

68-6M MACHINE BORING
3 MAY 1979 DATE BORING WAS TAKEN

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

FLOOD CONTROL FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA

BORING LOGS

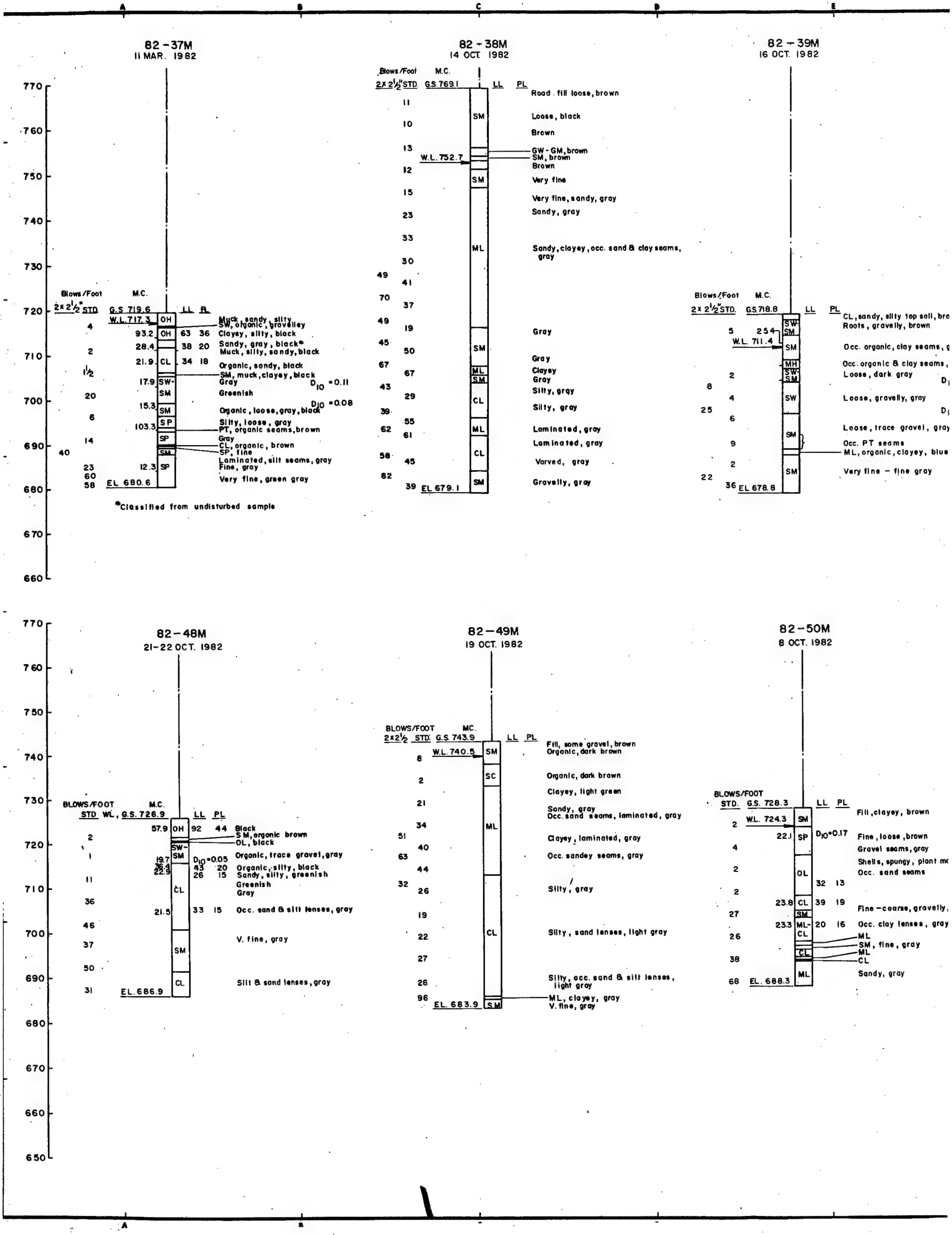
DESIGNED BY: PDM
DRAWN BY: GAO
CHECKED BY: LHB
SUBMITTED BY:
APPROVED:
DATE: OCT 1984

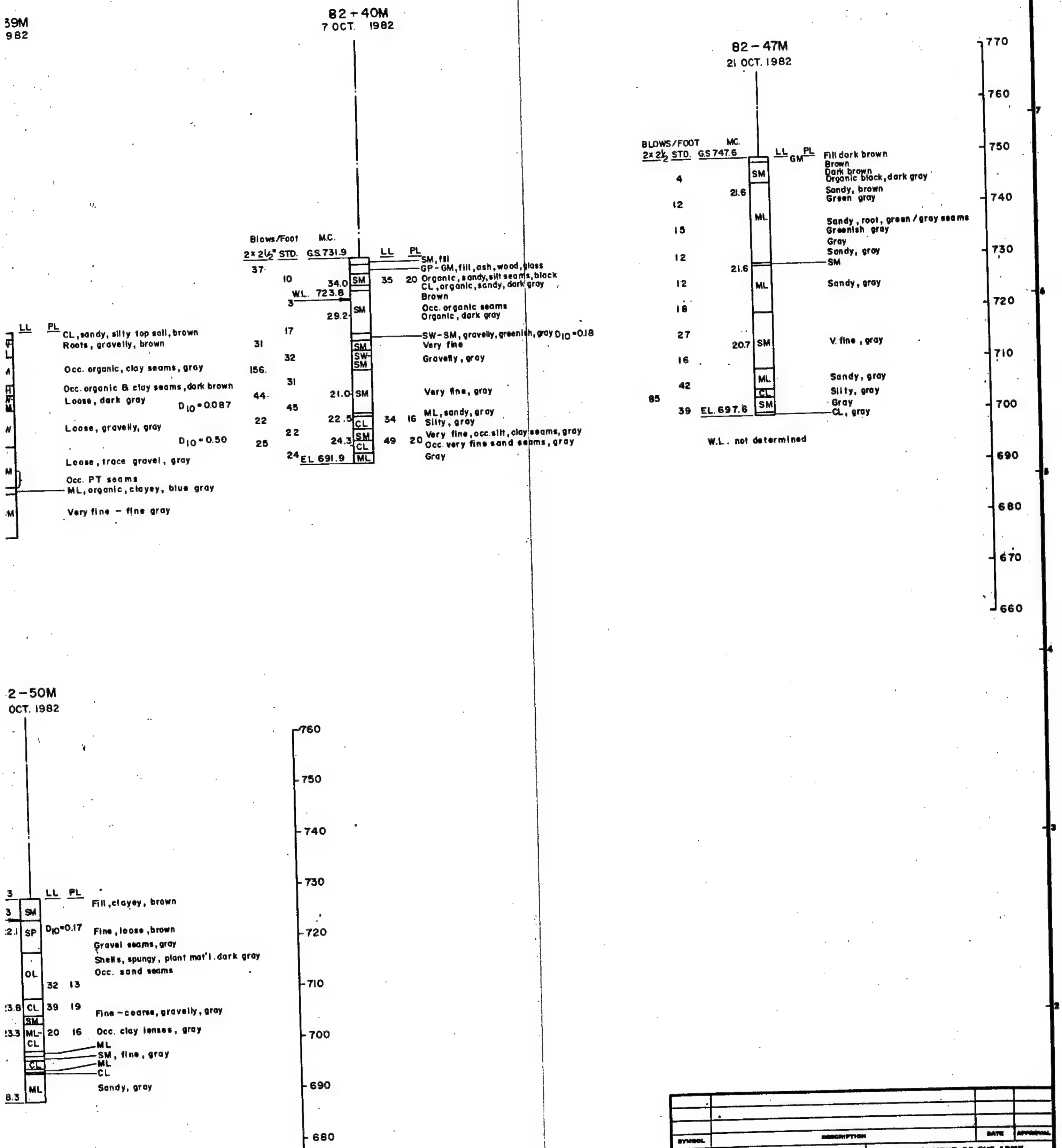
SAFETY PAYS

DRAWING NUMBER M34-CH-R-5/146

2

PLATE B-7


82-37M
11 MAR. 1982
Blows/Foot
2x2½"STD
M.C.
G.S 719.6
W.L.717.3
LL PL
Muck, sandy, silty
SW, organic, gravelley
Clayey, silty, black
Sandy, gray, black*
Muck, silty, sandy, black
Organic, sandy, black
SM, muck, clayey, black
Gray
Greenish
Organic, loose, gray, black
Silty, loose, gray
PT, organic seams, brown
Gray
CL, organic, brown
SP, fine
Laminated, silt seams, gray
Fine, gray
Very fine, green gray
EL 680.6
*Classified from undisturbed sample
82-38M
14 OCT 1982
G.S 769.1
Road fill loose, brown
Loose, black
Brown
GW-GM, brown
SM, brown
Brown
W.L. 752.7
Very fine
Very fine, sandy, gray
Sandy, gray
Sandy, clayey, occ. sand & clay seams, gray
Gray
Clayey
Silty, gray
Laminated, gray
Varved, gray
Gravelly, gray
EL 679.1
82-39M
16 OCT. 1982
G.S 718.8
W.L. 711.4
CL, sandy, silty top soil, brown
Roots, gravelly, brown
Occ. organic, clay seams
Occ. organic & clay seams
Loose, dark gray
Loose, gravelly, gray
Loose, trace gravel, gray
Occ. PT seams
ML, organic, clayey, blue
Very fine - fine gray
EL 678.8
82-48M
21-22 OCT. 1982
BLOWS/FOOT
STD
WL, G.S. 726.9
Black
SM, organic brown
OL, black
Organic, trace gravel, gray
Organic, silty, black
Sandy, silty, greenish
Greenish
Gray
Occ. sand & silt lenses, gray
V. fine, gray
Silt & sand lenses, gray
EL. 686.9
82-49M
19 OCT. 1982
G.S 743.9
W.L. 740.5
Fill, some gravel, brown
Organic, dark brown
Organic, dark brown
Clayey, light green
Sandy, gray
Occ. sand seams, laminated, gray
Clayey, laminated, gray
Occ. sandey seams, gray
Silty, gray
Silty, sand lenses, light gray
Silty, occ. sand & silt lenses, light gray
ML, clayey, gray
V. fine, gray
EL. 683.9
82-50M
8 OCT. 1982
G.S. 728.3
WL. 724.3
Fill, clayey, brown
Fine, loose, brown
Gravel seams, gray
Shells, spungy, plant
Occ. sand seams
Fine - coarse, gravelly
Occ. clay lenses, gray
SM, fine, gray
Sandy, gray
EL. 688.3



SYMBOL	DESCRIPTION	DATE / APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: PDM
DRAWN BY: GAO
CHECKED BY: LHB
SUBMITTED BY:

FLOOD CONTROL FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA

BORING LOGS

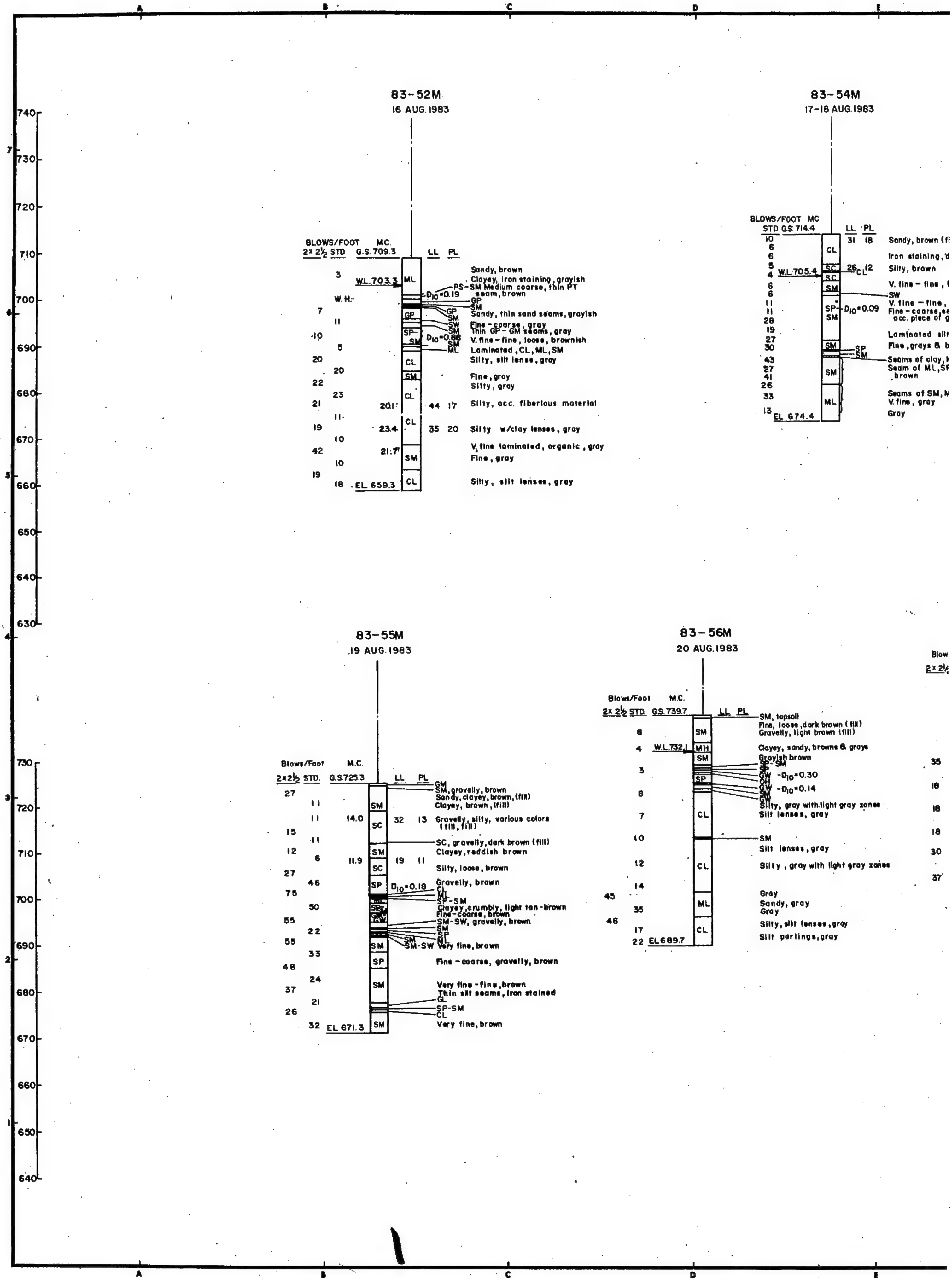
APPROVED:

DATE: OCT 1984

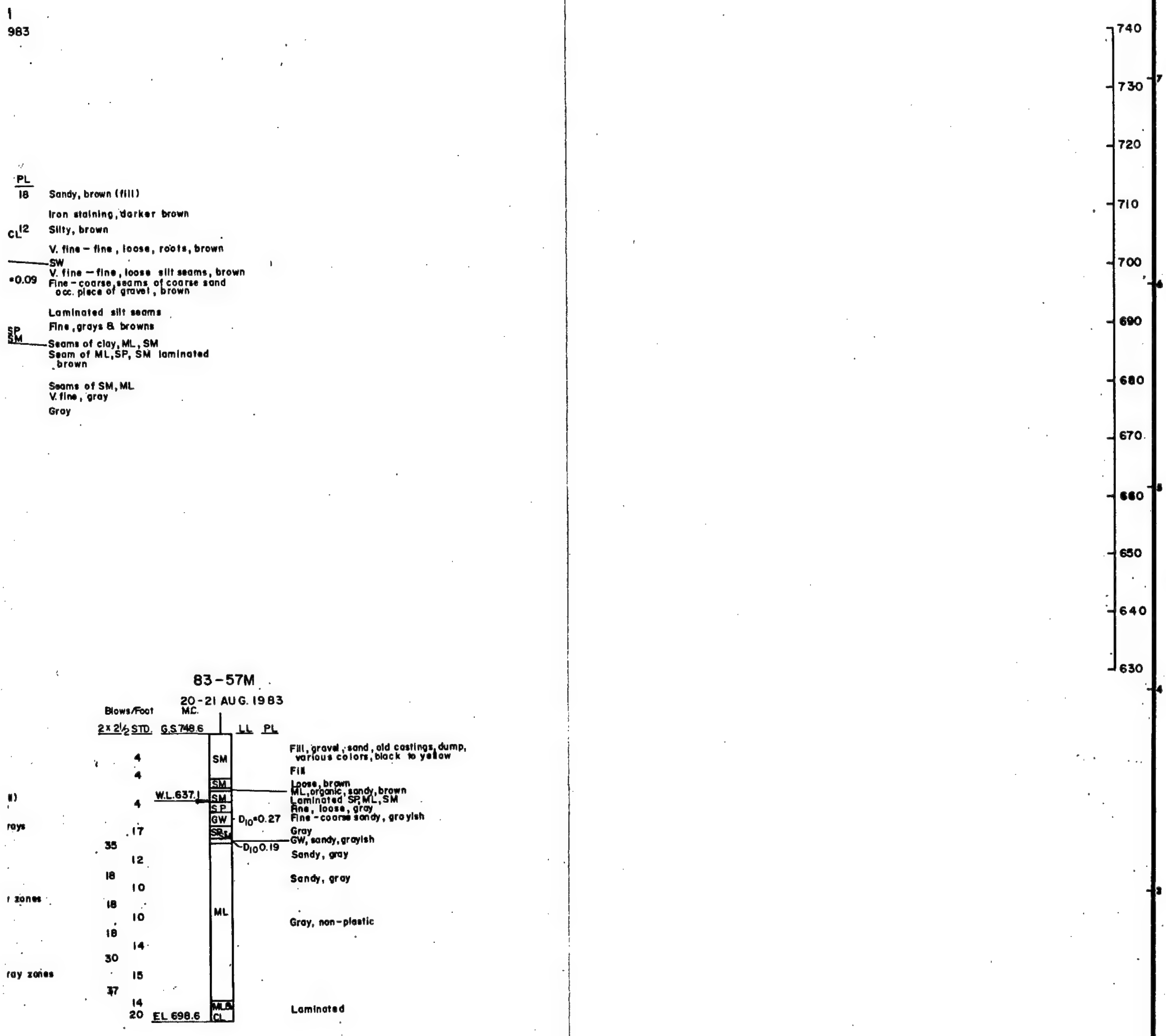
DRAWING NUMBER
M34-CH-R-5/147
SHEET OF

2

PLATE B-3



83-52M
16 AUG. 1983
BLOWS/FOOT 2x2½ STD
M.C. G.S. 709.3
LL PL
W.L. 703.3
W.H.
D_{10}=0.19
D_{10}=0.88
20.1 44 17
23.4 35 20
21.7
EL 659.3
Sandy, brown
Clayey, iron staining, grayish
PS-SM Medium coarse, thin PT seam, brown
Sandy, thin sand seams, grayish
Fine-coarse, gray
Thin GP-GM seams, gray
V. fine-fine, loose, brownish
Laminated, CL, ML, SM
Silty, silt lense, gray
Fine, gray
Silty, gray
Silty, occ. fibertous material
Silty w/clay lenses, gray
V. fine laminated, organic, gray
Fine, gray
Silty, silt lenses, gray
83-54M
17-18 AUG. 1983
BLOWS/FOOT STD
MC G.S. 714.4
LL PL
31 18
W.L. 705.4
26 CL 12
D_{10}=0.09
EL 674.4
Sandy, brown
Iron staining
Silty, brown
V. fine - fine
V. fine - fine
Fine - coarse, occ. piece of
Laminated silt
Fine, grays & b
Seams of clay
Seam of ML, SF brown
Seams of SM
V. fine, gray
Gray
83-55M
19 AUG. 1983
Blows/Foot 2x2½ STD.
M.C. G.S. 725.3
LL PL
14.0 32 13
11.9 19 11
D_{10}=0.18
EL 671.3
SM, gravelly, brown
Sandy, clayey, brown, (fill)
Clayey, brown, (fill)
Gravelly, silty, various colors (fill, fill)
SC, gravelly, dark brown (fill)
Clayey, reddish brown
Silty, loose, brown
Gravelly, brown
SP-SM
Clayey, crumbly, light tan-brown
Fine-coarse, brown
SM-SW, gravelly, brown
SM-SW Very fine, brown
Fine - coarse, gravelly, brown
Very fine - fine, brown
Thin silt seams, iron stained
SP-SM
Very fine, brown
83-56M
20 AUG. 1983
Blows/Foot 2x2½ STD.
M.C. G.S. 739.7
LL PL
W.L. 732.1
D_{10}=0.30
D_{10}=0.14
EL 689.7
SM, topsoil
Fine, loose, dark brown (fill)
Gravelly, light brown (fill)
Clayey, sandy, browns & grays
Grayish brown
Silty, gray with light gray zones
Silt lenses, gray
Silt lenses, gray
Silty, gray with light gray zones
Gray
Sandy, gray
Gray
Silty, silt lenses, gray
Silt partings, gray
Blow 2x2½



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: PDM
DRAWN BY: GAO
CHECKED BY: LHB
SUBMITTED BY:

FLOOD CONTROL FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA

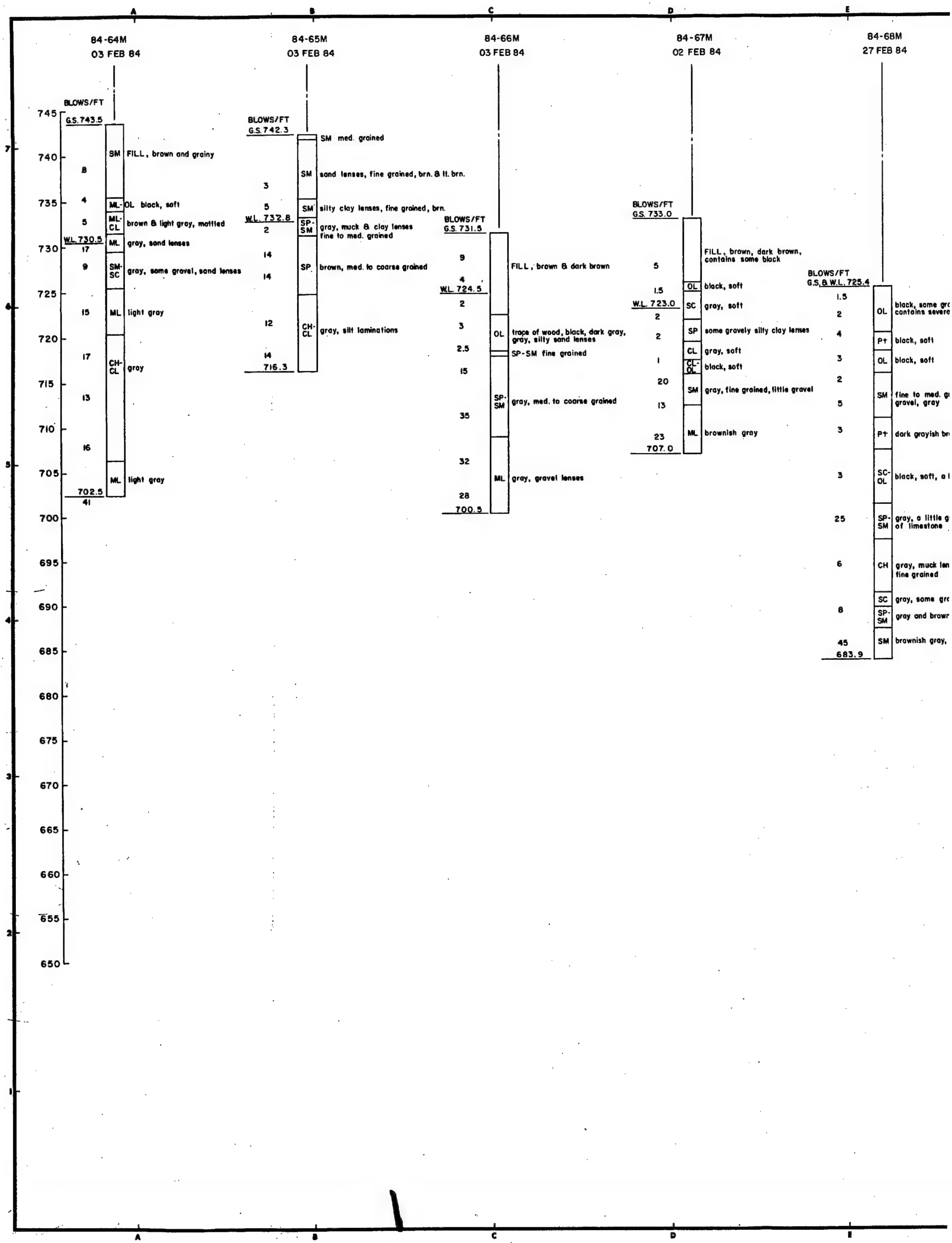
BORING LOGS

APPROVED:
DATE: OCT 1984
SCALE:
DRAWING NUMBER
M34-CH-R-5/148
SHEET OF

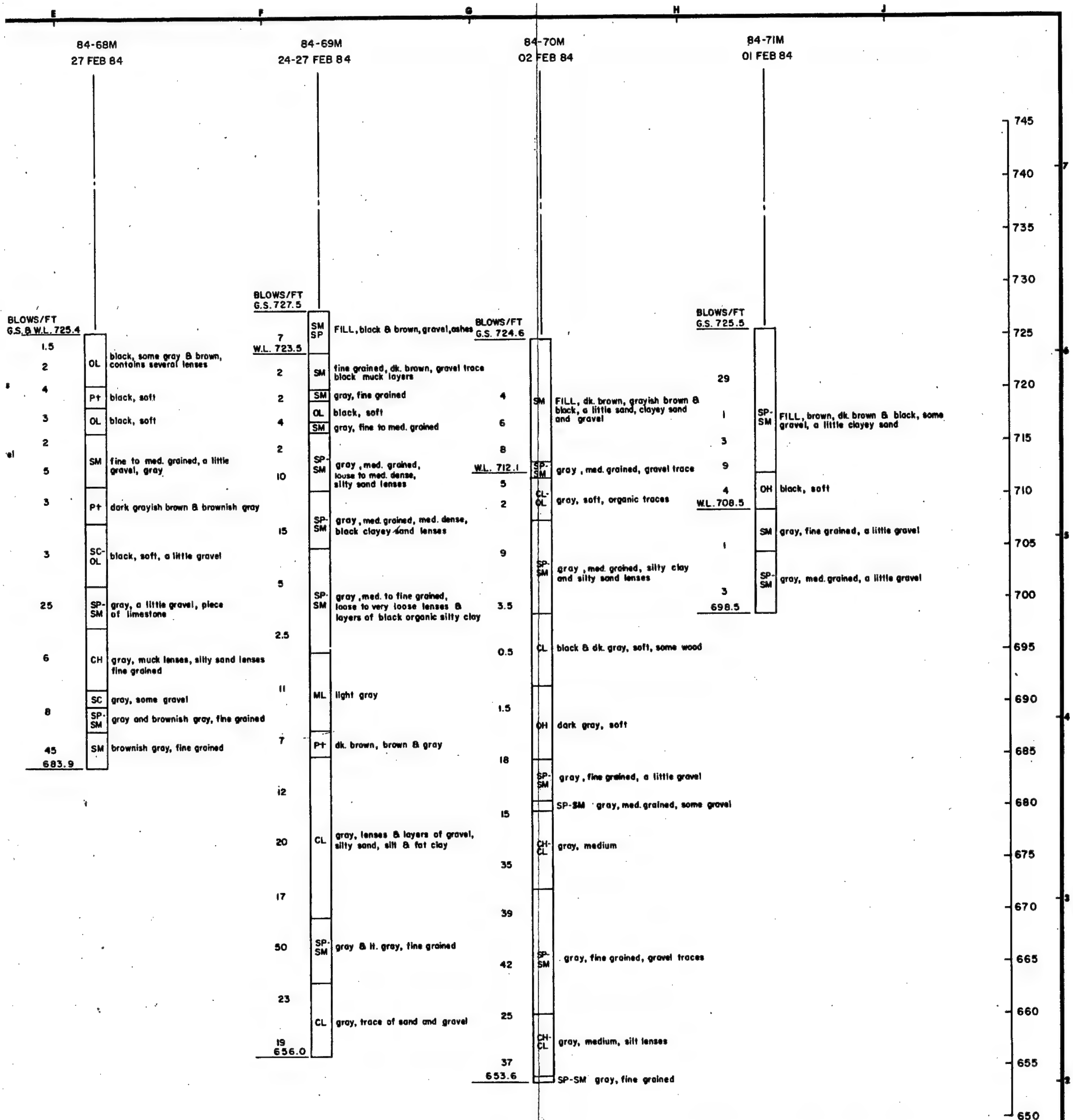
SAFETY PAYS

2

PLATE B-4



A
B
C
D
E
84-64M
03 FEB 84
BLOWS/FT
G.S. 743.5
SM FILL, brown and grainy
ML-OL black, soft
ML-CL brown & light gray, mottled
W.L. 730.5
ML gray, sand lenses
SM-SC gray, some gravel, sand lenses
ML light gray
CH-CL gray
ML light gray
8
4
5
17
9
15
17
13
16
702.5
41
84-65M
03 FEB 84
BLOWS/FT
G.S. 742.3
SM med. grained
SM sand lenses, fine grained, brn. & lt. brn.
SM silty clay lenses, fine grained, brn.
W.L. 732.8
SP-SM gray, muck & clay lenses fine to med. grained
SP brown, med. to coarse grained
CH-CL gray, silt laminations
3
5
2
14
14
12
14
716.3
84-66M
03 FEB 84
BLOWS/FT
G.S. 731.5
FILL, brown & dark brown
W.L. 724.5
OL trace of wood, black, dark gray, gray, silty sand lenses
SP-SM fine grained
SP-SM gray, med. to coarse grained
ML gray, gravel lenses
9
4
2
3
2.5
15
35
32
28
700.5
84-67M
02 FEB 84
BLOWS/FT
G.S. 733.0
FILL, brown, dark brown, contains some black
OL black, soft
W.L. 723.0
SC gray, soft
SP some gravely silty clay lenses
CL gray, soft
CL-OL black, soft
SM gray, fine grained, little gravel
ML brownish gray
5
1.5
2
2
1
20
13
23
707.0
84-68M
27 FEB 84
BLOWS/FT
G.S. & W.L. 725.4
OL black, some gr contains sever
Pt black, soft
OL black, soft
SM fine to med. g gravel, gray
Pt dark grayish br
SC-OL black, soft, a l
SP-SM gray, a little g of limestone
CH gray, muck len fine grained
SC gray, some gr
SP-SM gray and brow
SM brownish gray,
1.5
2
4
3
2
5
3
3
25
6
8
45
683.9
745
740
735
730
725
720
715
710
705
700
695
690
685
680
675
670
665
660
655
650



SEE DRAWING M34-CH-R-5/68 FOR BORING LEGEND AND NOTES

SYMBOL	DESCRIPTION	DATE	APPROVAL

BONESTROO, ROSENE, ANDERLIK & ASSOC., INC.
CONSULTING ENGINEERS
St. Paul, Minnesota

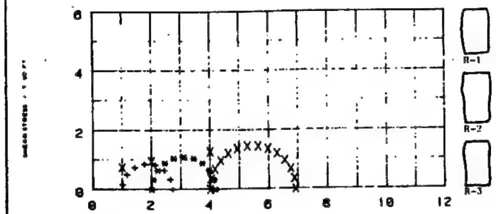
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

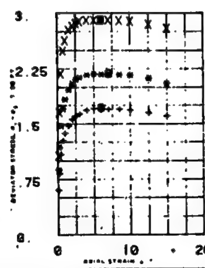
DESIGNED BY: MRR
DRAWN BY: KRL
CHECKED BY: MTR
SUBMITTED BY:

FLOOD CONTROL · FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
CHASKA CREEK
BORING LOGS - 84-64M thru 84-71M

APPROVED:
DATE: OCT 1984
SCALE: AS SHOWN
DRAWING NUMBER
M34-CH-R-5/149
SHEET OF

2





SPECIMEN NO			1	2	3	
INITIAL	WATER CONTENT %	w_o	24.9	25.0	29.4	
	DRY DENSITY LB/CU FT	γ_{d_o}	87.9	88.2	82.3	
	SATURATION %	S_o	75.	78.	78.	
	VOID RATIO	e_o	.95	.91	1.05	
BEFORE SHEAR	WATER CONTENT %	w_c	32.6	32.7	35.9	
	DRY DENSITY LB/CU FT	γ_{d_c}	89.1	91.9	90.	
	SATURATION %	S_c	99.	100.	100.	
	VOID RATIO	e_c	.89	.84	.87	
	FINAL BACK PRESSURE T/SQ FT	u_o	5.5	5.5	5.5	
MINOR PRINCIPAL STRESS T/SQ FT		σ_3	1.	2.	4.	
MAXIMUM DEVIATOR STRESS T/SQ FT			1.72	2.19	2.91	
TIME TO FAILURE, MIN		t_1	52	60	62	
ULTIMATE DEVIATOR STRESS T/SQ FT			1.81	2.86	2.79	
INITIAL DIAMETER IN		D_o	1.4	1.4	1.41	
INITIAL HEIGHT IN		H_o	2.90	2.97	2.96	

CONTROLLED-STRAIN TEST

DESCRIPTION OF SPECIMENS Sandy clay, CH

LL 51 PL 18 PI 33 G_s 2.7

TYPE OF SPECIMEN UNDISTURBED TYPE OF TEST R

REMARKS

PROJECT CHASKA FLOOD CONTROL NCS-IA-80-118-ED-H

BORING NO. 80-20H SAMPLE NO. 1

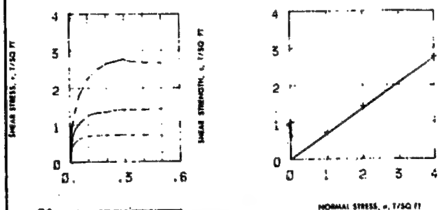
DEPTH 21.0-22.0

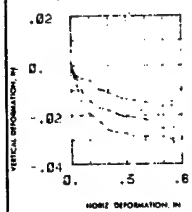
LAB NO. 80/227 DATE 30 DEC 1980

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 8





TEST NO			1	2	3	
INITIAL	WATER CONTENT	w	24.6 %	24.1 %	24. %	%
	VOID RATIO	e_o	.81	.84	.80	
	SATURATION	S_o	82. %	78. %	75. %	%
	DRY DENSITY LB/CU FT	γ_d	92.9	91.6	90.3	
VOID RATIO AFTER CONSOLIDATION		e	.78	.78	.72	
TIME FOR 50 PERCENT CONSOLIDATION, MIN		t_{50}				
FINAL	WATER CONTENT	w_f	28.3 %	26.2 %	[illegible] %	%
	VOID RATIO	e_f	.74	.71	.62	
	SATURATION	S_f	100. %	100	100 %	%
NORMAL STRESS T/SQ FT		σ	1.	2.	4.	
MAXIMUM SHEAR STRESS T/SQ FT		τ_{max}	.75	1.45	2.77	
ACTUAL TIME TO FAILURE, MIN		t_f	698	1478	780	
RATE OF STRAIN, IN/MIN		x .0001	5.57	5.4	5.71	
ULTIMATE SHEAR STRESS T/SQ FT			.7	1.45	2.66	

SHEAR STRENGTH PARAMETERS

φ 34.2

tan φ 0.0[illegible]

c T/SQ FT

☐ CONTROLLED STRESS

☒ CONTROLLED STRAIN

TYPE OF SPECIMEN UNDISTURBED

5. IN SQUARE .506 IN THICK

CLASSIFICATION

LL PL PI 13 G_s 2.7

REMARKS

PROJECT CHASKA FLOOD CONTROL NCS-IA-80-118-ED-H

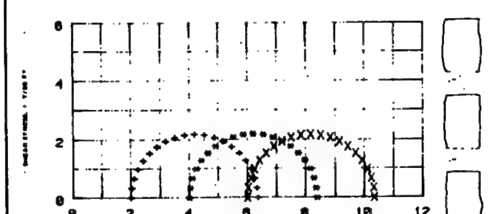
AREA NCS JAN NO: 80.227

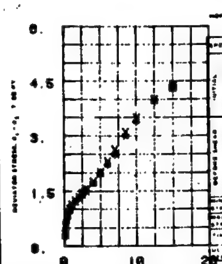
BORING NO. 80 20H SAMPLE NO. 1

DEPTH, FT 21.0-22.0 DATE

DIRECT SHEAR TEST REPORT

ENG FORM 2092 1 JUN 65 PREVIOUS EDITIONS ARE OBSOLETE TRANSLUCENT PLATE II-3





SPECIMEN NO			1	2	3	
INITIAL	WATER CONTENT %	w_o	19.8	20.	20.6	
	DRY DENSITY LB/CU FT	γ_{d_o}	108.6	108.6	107.0	
	SATURATION %	S_o	[illegible]	[illegible]	[illegible]	
	VOID RATIO	e_o	.55	.55	.58	
BEFORE SHEAR	WATER CONTENT %	w_c	19.7	20.	20.4	
	DRY DENSITY LB/CU FT	γ_{d_c}	110.	109.9	109.3	
	SATURATION %	S_c	100.	100.	100.	
	VOID RATIO	e_c	[illegible]	[illegible]	.54	
	FINAL BACK PRESSURE T/SQ FT	u_o	0.	0.	0.	
MINOR PRINCIPAL STRESS T/SQ FT		σ_3	2.	4.	6.	
MAXIMUM DEVIATOR STRESS T/SQ FT			4.88	4.89	4.84	
TIME TO FAILURE, MIN		t_1	[illegible]	[illegible]	29	
ULTIMATE DEVIATOR STRESS T/SQ FT			4.88	4.89	4.84	
INITIAL DIAMETER IN		D_o	1.4	1.89	1.89	
INITIAL HEIGHT IN		H_o	1.00	[illegible]	[illegible]	

CONTROLLED-Strain TEST

DESCRIPTION OF SPECIMENS Sandy lean clay, CL

LL 44 PL 17 PI 27 G_s 2.7

TYPE OF SPECIMEN UNDISTURBED TYPE OF TEST Q

REMARKS Gray, stiff consistency, high strength at PL, loss shine, slow shake response, calcareous.

PROJECT CHASKA NCS-IA-84-4-ED-BH

BORING NO. B1-82 SAMPLE NO.

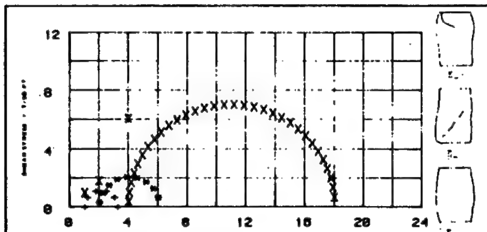
DEPTH, FT 88.0-81.0

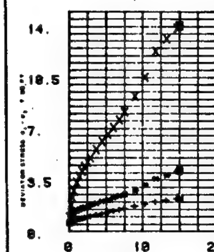
LABORATORY 84/84 DATE 27 DEC 1983

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 1





SPECIMEN NO			1	2	3	
INITIAL	WATER CONTENT %	w_o	15.9	15.	18.7	
	DRY DENSITY LB/CU FT	γ_{d_o}	115.0	110.0	115.	
	SATURATION %	S_o	[illegible]	41.	[illegible]	
	VOID RATIO	e_o	.40	.45	.47	
BEFORE SHEAR	WATER CONTENT %	w_c	18.5	14.9	16.	
	DRY DENSITY LB/CU FT	γ_{d_c}	110.0	120.5	117.9	
	SATURATION %	S_c	100.	100.	100.	
	VOID RATIO	e_c	.45	.4	.44	
	FINAL BACK PRESSURE T/SQ FT	u_o	4.0	4.00	4.00	
MINOR PRINCIPAL STRESS T/SQ FT		σ_3	1.	2.	4.	
MAXIMUM DEVIATOR STRESS T/SQ FT			2.27	4.18	14.1	
TIME TO FAILURE, MIN		t_1	1282	1381	1324	
ULTIMATE DEVIATOR STRESS T/SQ FT			2.27	4.18	14.1	
INITIAL DIAMETER IN		D_o	1.4	1.4	1.4	
INITIAL HEIGHT IN		H_o	2.99	2.98	2.98	

CONTROLLED-STRAIN TEST

DESCRIPTION OF SPECIMENS Gravelly clayey sand, SC

LL PL PI G_s 2.71

TYPE OF SPECIMEN UNDISTURBED TYPE OF TEST R

REMARKS Due to gravel in material, specimens R-1 and R-2 required undesirable pot sing. Specimen R-3 required less pot sing.

PROJECT CHASKA NCS-IA-84-4-ED-BH

BORING NO. 86-8BH SAMPLE NO. 2

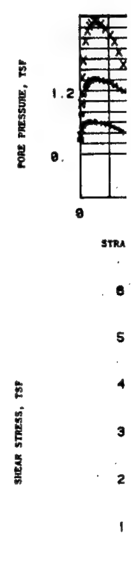
DEPTH, FT 16.5-17.7

LABORATORY 84/84 DATE 11 JAN 1984

TRIAXIAL COMPRESSION TEST REPORT

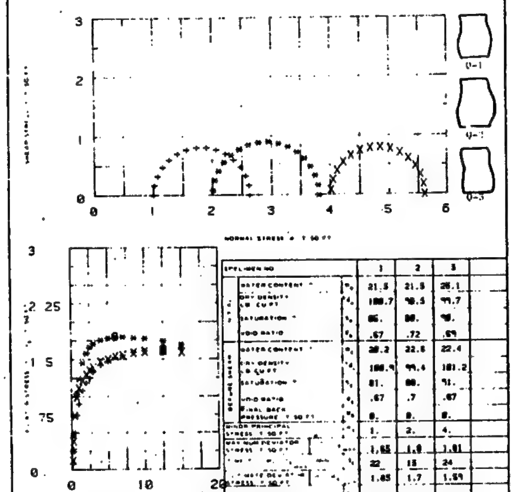
ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure



REMARKS: COMPUTER
SYMBOLS SAME AS FO
R TRIAXIAL TEST: P
MONITORED DURING S

MRD Form 756, 1 May



SPECIMEN NO			1	2	3
INITIAL	WATER CONTENT %	w_o	21.5	21.5	25.1
	DRY DENSITY LB/CU FT	γ_{d_o}	100.7	98.5	99.7
	SATURATION %	S_o	85.	80.	90.
	VOID RATIO	e_o	.67	.72	.69
BEFORE SHEAR	WATER CONTENT %	w_c	20.2	22.5	22.4
	DRY DENSITY LB/CU FT	γ_{d_c}	100.9	99.4	101.2
	SATURATION %	S_c	81.	80.	91.
	VOID RATIO	e_c	.67	.7	.67
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.	0.	0.
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.	2.	4.
MAXIMUM DEVIATOR STRESS, T/SQ FT			1.65	1.8	1.81
TIME TO $(\sigma_1-\sigma_3)_{max}$, MIN		t_f	22	15	24
ULTIMATE DEVIATOR STRESS, T/SQ FT			1.65	1.7	1.59
INITIAL DIAMETER, IN		D_o	1.39	1.4	1.4
INITIAL HEIGHT, IN		H_o	2.98	2.96	2.97

STRAIN

TYPE OF SPECIMEN: UNDISTURBED; TYPE OF TEST: Q

G_s 2.7

REMARKS: Gray, brittle, medium consistency, low strength at PL, no dilatancy, ... trace fine sand and ... gravel ... pores ... 0.70.

PROJECT: CHASKA FLOOD CONTROL NCS-IA-80-118-ED-H

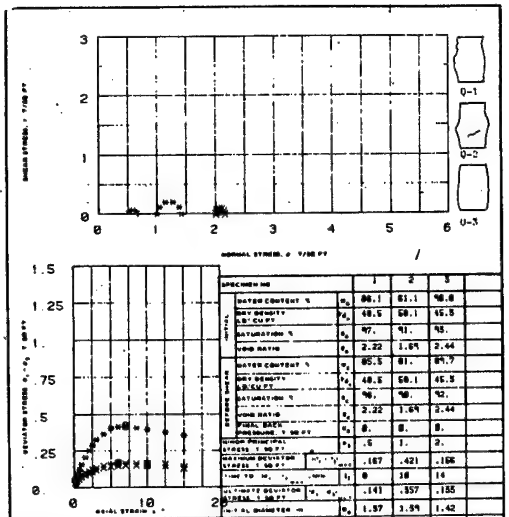
BORING NO.: 80-28M; SAMPLE NO.: 2

DEPTH/ELEV.: 20.8-26.9

LABORATORY: 80/227; DATE: ... 1980

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 2089 ... TRANSLUCENT EM 1110-2-1906 Figure 11



SPECIMEN NO			1	2	3
INITIAL	WATER CONTENT %	w_o	86.1	61.1	90.8
	DRY DENSITY LB/CU FT	γ_{d_o}	48.5	58.1	45.5
	SATURATION %	S_o	97.	91.	95.
	VOID RATIO	e_o	2.22	1.69	2.44
BEFORE SHEAR	WATER CONTENT %	w_c	85.5	81.	89.7
	DRY DENSITY LB/CU FT	γ_{d_c}	48.5	58.1	45.5
	SATURATION %	S_c	96.	90.	92.
	VOID RATIO	e_c	2.22	1.69	2.44
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.	0.	0.
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1.	2.
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1-\sigma_3)_{max}$	.167	.421	.156
TIME TO $(\sigma_1-\sigma_3)_{max}$, MIN		t_f	8	18	14
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1-\sigma_3)_{ult}$	.141	.357	.155
INITIAL DIAMETER, IN		D_o	1.57	1.59	1.42
INITIAL HEIGHT, IN		H_o	3.00	2.97	2.95

CONTROLLED- TEST

DESCRIPTION OF SPECIMENS (Visual) Q-1 & Q-3 Sandy peat, OH; Q-2 Peat, OH

LL; PL; PI; G_s 2.5

TYPE OF SPECIMEN: UNDISTURBED; TYPE OF TEST: Q

REMARKS: Black, soft consistency, low strength at PL for Q-1 & Q-3 and medium strength at PL for Q-2, no shine, rapid shake response.

PROJECT: CHASKA NCS-IA-82-58-ED-GH

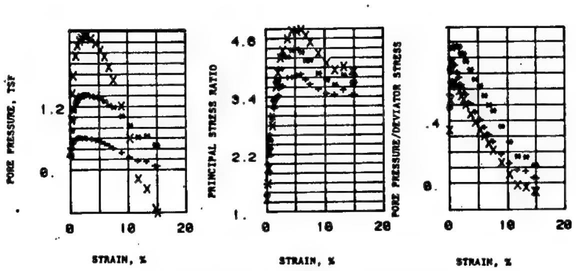
BORING NO.: 82-37M; SAMPLE NO.: 1

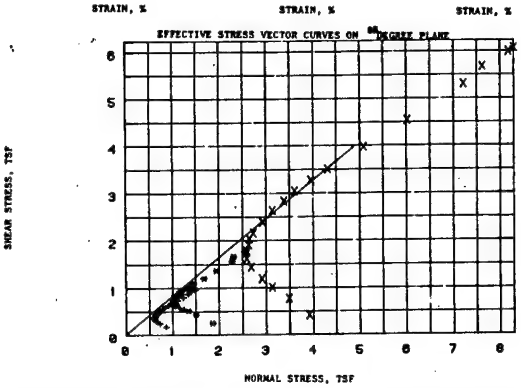
DEPTH/ELEV.: 6.8-7.5

LABORATORY: 82/118; DATE: 01 JUL 1982

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 PREVIOUS EDITION OBSOLETE TRANSLUCENT (EM 1110-2-1906)





REMARKS: COMPUTER PRINT-OUT
SYMBOLS SAME AS FORM 2089
R TRIAXIAL TEST: PORE PRESSURE
MONITORED DURING SHEAR

MRD Form 756, 1 May 80

PROJECT: CHASKA NCS-IA-84-4-ED-GH
BORING NO: 85-58M SAMPLE NO: 2
DEPTH/ELEV: 10.5-17.7
MRD LAB NO: 84/54 DATE: 11 JAN 1984

TRIAXIAL COMPRESSION TEST REPORT

FIGURE: .

2

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

FLOOD CONTROL FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
TRIAXIAL TESTS
BORINGS 80-28M, 82-37M, 83-52M, 83-57M

DESIGNED BY: / DRAWN BY: / CHECKED BY:

SUBMITTED BY:

APPROVED:

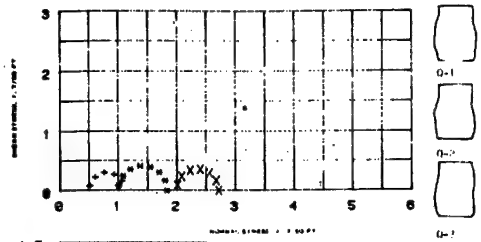
DATE: OCT 1984

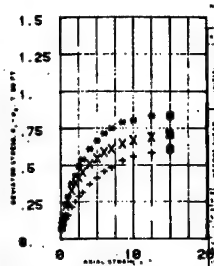
SCALE: / SPEC. NO.

DRAWING NUMBER
M34-CH-R-5/151
SHEET OF

SAFETY PAYS

PLATE B-6





Specimen no.	1	2	3
Water content %	19.7	19.0	20.7
[illegible]	100.9	101.5	107.0
Saturation %	99.	100.	100.
Void ratio	.55	.52	.55
Water content %	19.6	19.7	20.6
[illegible]	100.9	101.5	107.0
Saturation %	98.	100.	100.
Void ratio	.55	.52	.55
[illegible] pressure	0.	0.	0.
[illegible]	.5	1.	2.
[illegible]	.609	.687	.71
[illegible]	20	20	20
[illegible]	.609	.687	.71
[illegible]	1.09	1.4	1.4
[illegible]	[illegible]	[illegible]	[illegible]

CONTROLLED-STRESS TEST: Strain

DESCRIPTION OF SPECIMENS: Clayey sand, SC

LL 26 PL 13 PI 13 Gs 2.67 TYPE OF SPECIMEN: UNDISTURBED TYPE OF TEST: R

REMARKS: Dark brown, medium consistency, medium strength at PL, dull [illegible], slow shake response, slightly calcareous.

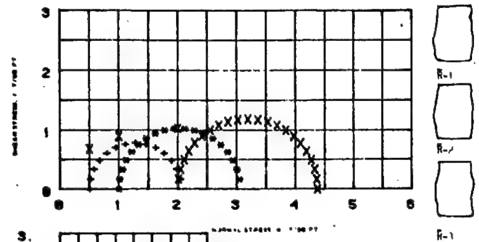
PROJECT: CHINKA NCB-IR-84-4-ED-BH

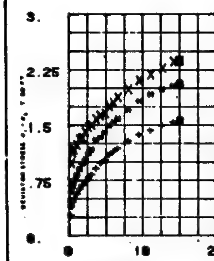
BORING NO.: 83-56 SAMPLE NO.: 1

LAB NO.: 84/84 DATE: 27 DEC 1983

TRIAXIAL COMPRESSION TEST REPORT

Figure 1





Specimen no.	1	2	3
Water content %	20.1	19.9	19.8
[illegible]	109.	109.5	107.7
Saturation %	100.	99.	98.
Void ratio	.55	.54	.55
Water content %	19.8	19.2	18.9
[illegible]	109.4	110.2	110.8
Saturation %	100.	100.	100.
Void ratio	.50	.51	.5
[illegible] pressure	2.00	2.00	2.00
[illegible]	.5	1.	2.
[illegible]	1.50	2.00	2.07
[illegible]	1271	1007	1005
[illegible]	1.50	2.00	2.07
[illegible]	1.41	1.41	1.09
[illegible]	2.99	2.99	2.99

CONTROLLED-STRESS TEST: STRAIN

B value = 1.00 0.98 1.00

Clayey sand, SC

LL 27 PL 13 PI 14 Gs 2.67 TYPE OF SPECIMEN: UNDISTURBED TYPE OF TEST: R

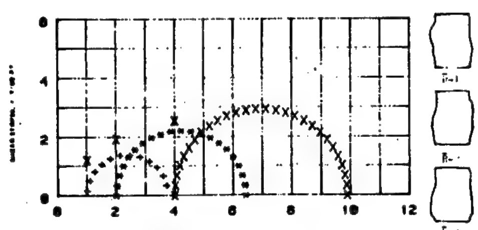
PROJECT: CHINKA NCB-IR-84-4-ED-BH

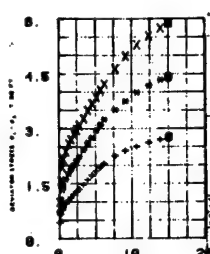
BORING NO.: 83-56 SAMPLE NO.: 1

LAB NO.: 84/84 DATE: 27 DEC 1983

TRIAXIAL COMPRESSION TEST REPORT

Figure 1





Specimen no.	1	2	3
Water content %	12.2	18.	12.5
[illegible]	118.0	118.6	118.5
Saturation %	86.	80.	78.
Void ratio	.4	.4	.45
Water content %	14.5	14.4	13.8
[illegible]	121.9	120.	120.9
Saturation %	100.	100.	100.
Void ratio	.38	.36	.36
[illegible] pressure	5.54	5.54	5.54
[illegible]	1.	2.	4.
[illegible]	2.77	4.40	5.09
[illegible]	1007	1001	1279
[illegible]	2.77	4.40	5.09
[illegible]	1.4	1.4	1.41
[illegible]	2.99	2.99	3.

CONTROLLED-STRESS TEST: STRAIN

DESCRIPTION OF SPECIMENS: Clayey sand, SC

Gs 2.66 TYPE OF SPECIMEN: UNDISTURBED TYPE OF TEST: R

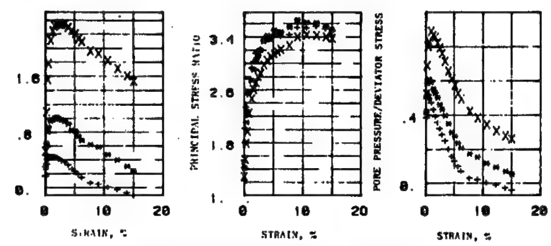
PROJECT: CHINKA NCB-IR-84-4-ED-BH

BORING NO.: 83-56 SAMPLE NO.: 1

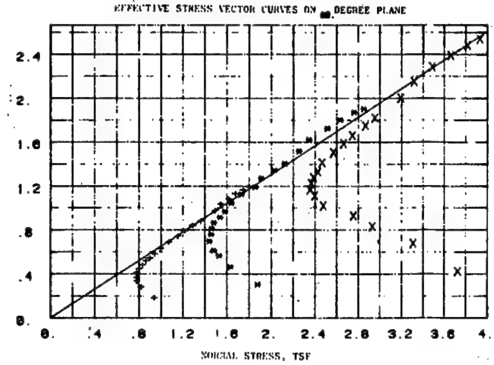
DEPTH/ELEV.: 7.0-8.5

LAB NO.: 84/84 DATE: 10 JAN 1984

TRIAXIAL COMPRESSION TEST REPORT



EFFECTIVE STRESS VECTOR CURVES ON 45 DEGREE PLANE



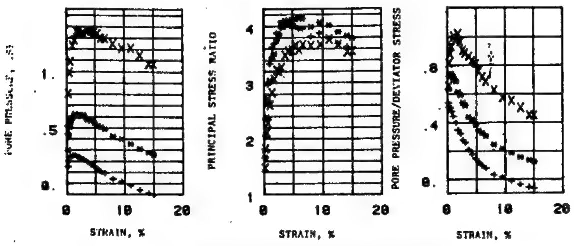
REMARKS: COMPUTER PRINT-OUT
SYMBOLS SAME AS FORM 7089
TRIAXIAL TEST: PORE PRESSURE
DURING SHEAR

MRD Form 756, 1 May 80

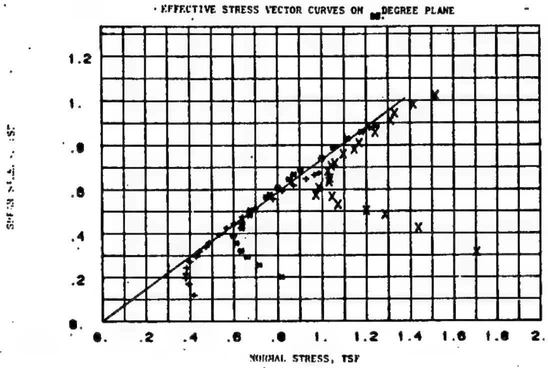
PROJECT: CHINKA NCB-IR-84-4-ED-BH
BORING NO: 83-56 SAMPLE NO: 1
DEPTH/ELEV: 7.0-8.5
MRD LAB NO: 84/84 DATE: 10 JAN 1984

TRIAXIAL COMPRESSION TEST REPORT

FIGURE: 6



EFFECTIVE STRESS VECTOR CURVES ON 45 DEGREE PLANE



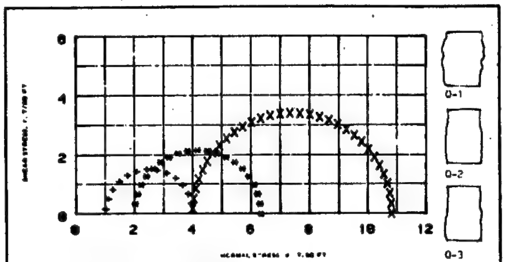
REMARKS: COMPUTER PRINT-OUT
SYMBOLS SAME AS FORM 2089
TRIAXIAL TEST: PORE PRESSURE
MONITORED DURING SHEAR

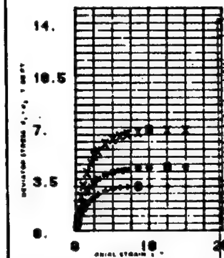
MRD Form 756, 1 May 80

PROJECT: CHASKA NCS-IR-84-4-ED-GH
BORING NO: 83-54 SAMPLE NO: 1
DEPTH/ELEV:
MRD LAB NO: 84/84 DATE: 27 DEC 1983

TRIAXIAL COMPRESSION TEST REPORT

FIGURE: 20





		1	2	3	
Water content, %	w_o	18.5	14.	18.8	
Dry density, lb/cu ft	γ_{d}	110.7	112.8	112.9	
Saturation, %	S_o	70.	70.	75.	
Void ratio	e_o	.48	.48	.47	
Water content, %	w_c	18.4	18.9	18.2	
Dry density, lb/cu ft	γ_{d}	114.0	118.7	116.0	
Saturation, %	S_c	88.	88.	91.	
Void ratio	e_c	.46	.48	.46	
Back pressure, T/sq ft	u_o	0.	0.	0.	
Minor principal stress, T/sq ft	σ_3	1.	2.	4.	
Maximum deviator stress, T/sq ft	max	8.01	4.88	8.02	
Time to failure, min	t_f	18	34	35	
Ultimate deviator stress, T/sq ft		6.	4.82	8.79	
Initial diameter, in.	D_o	1.41	1.4	1.41	
Initial height, in.	H_o	2.96	2.98	2.98	

Controlled: Strain

Description of specimens: Clayey sand, SC

LL 32 PL 11 PI 19 Gs 2.66 Type of specimen: UNDISTURBED Type of test: R

Remarks: Mottled brown, stiff consistency, low strength at PL, medium shake response, highly calcareous.

Project: CHASKA NCS-IR-84-4-ED-GH

Boring no. 83-55 Sample no. 1

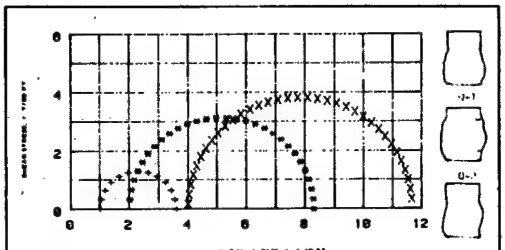
Depth/elev: 10.5-17.7

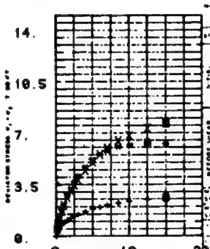
Lab no: 84/84 Date: 27 DEC 1983

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 2089 (EM 1110-2-1906)

Figure 22





		1	2	3	
Water content, %	w_o	12.7	11.8	11.4	
Dry density, lb/cu ft	γ_{d}	121.9	128.7	127.1	
Saturation, %	S_o	84.	94.	94.	
Void ratio	e_o	.84	.34	.88	
Water content, %	w_c	12.8	11.5	11.4	
Dry density, lb/cu ft	γ_{d}	121.9	128.7	127.8	
Saturation, %	S_c	88.	98.	98.	
Void ratio	e_c	.84	.34	.88	
Back pressure, T/sq ft	u_o	0.	0.	0.	
Minor principal stress, T/sq ft	σ_3	1.	2.	4.	
Maximum deviator stress, T/sq ft	max	3.8	6.8	7.87	
Time to failure, min	t_f	88	27	82	
Ultimate deviator stress, T/sq ft		2.8	6.28	7.87	
Initial diameter, in.	D_o	1.41	1.4	1.41	
Initial height, in.	H_o	3.00	3.00	3.00	

Controlled: Strain

Description of specimens: Gravelly clayey sand, SC

LL 19 PL 11 PI Gs 2.71 Type of specimen: UNDISTURBED Type of test: R

Remarks: Mottled brown, stiff consistency, low strength at PL, nil-fine, medium shake response, highly calcareous, pockets of silt. All 3 specimens required approximately 1½ hours of pressing.

Project: CHASKA NCS-IR-84-4-ED-GH

Boring no. 83-56 Sample no.

Depth/elev: 16.5-17.7

Lab no: 84/84 Date: 11 JAN 1984

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 2089 (EM 1110-2-1906)

Figure 6

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY:

FLOOD CONTROL FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA

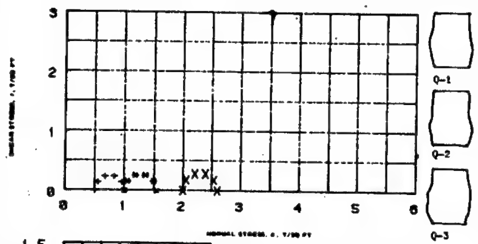
TRIAXIAL TESTS
BORING 83-54M and 83-56M

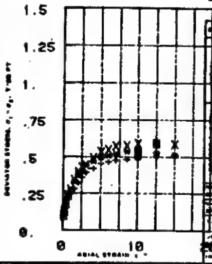
APPROVED:
DATE: OCT 1984
SCALE:
DRAWING NUMBER M34-CH-R-5/152
SHEET OF

SAFETY PAYS

2

PLATE B-7





Specimen No.		1	2	3
Water content, %	w_o	27.2	31.4	28.
Dry density, lb/cu ft	γ_o	97.8	91.1	97.1
Saturation, %	S_o	100.	[illegible]	100.
Void ratio	e_o	.7	.85	.7
Water content, %	w_f	27.	31.2	28.1
Dry density	γ_f	97.8	91.1	97.4
Saturation, %	S_f	100.	100.	99.
Void ratio	e_f	.7	.82	.7
Back pressure, T/sq ft	u_b	0.	0.	0.
Minor principal stress, T/sq ft	σ_3	.5	1.	2.
Maximum deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{max}$	.[illegible]	.644	.[illegible]
Time to $(\sigma_1-\sigma_3)_{max}$, min	t_1	21	21	20
Ultimate deviator stress, T/sq ft	$(\sigma_1-\sigma_3)_{ult}$	.[illegible]	.518	.[illegible]
Initial diameter, in.	D_o	1.4	1.4	1.4
Initial height, in.	H_o	3.00	2.99	3.01

Controlled- Test

Description of specimens Sandy clay, CL

LL 32 PL 13 PI 19 G_s 2.66 Type of specimen UNDISTURBED Type of test Q

Remarks Dark gray, soft consistency, low strength at PL, gloss shine, fast shake response, highly calcareous, slightly organic odor.

Project CHASKA NCS-IA-82-186-ED-GH

Boring No. 82-50 Sample No. 2

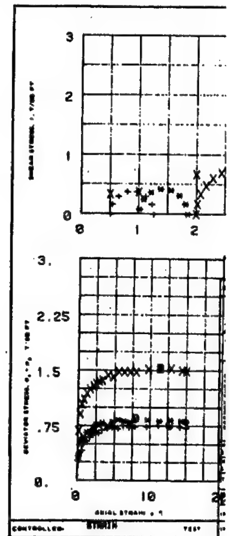
Depth/Elev. 18-18

Lab No. 85/67 Date 08 MAR 1983

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE (EM 1110-2-1906)

Figure 13



Controlled- STRAIN Test

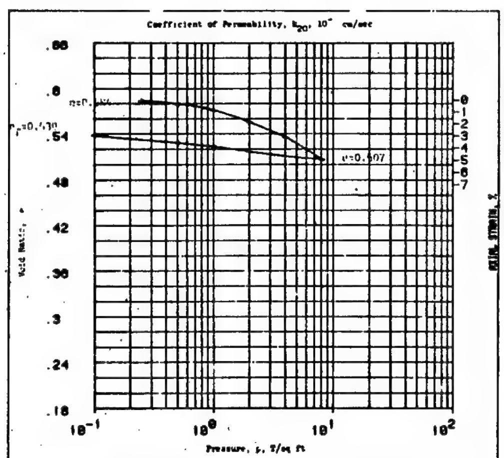
Description of specimens Sandy clay, CL

LL 32 PL 13 PI 19 G_s 2.66

Remarks Low shear strength of $\bar{R}$-2 may be due to material variation and lower density.

B value = 1.00

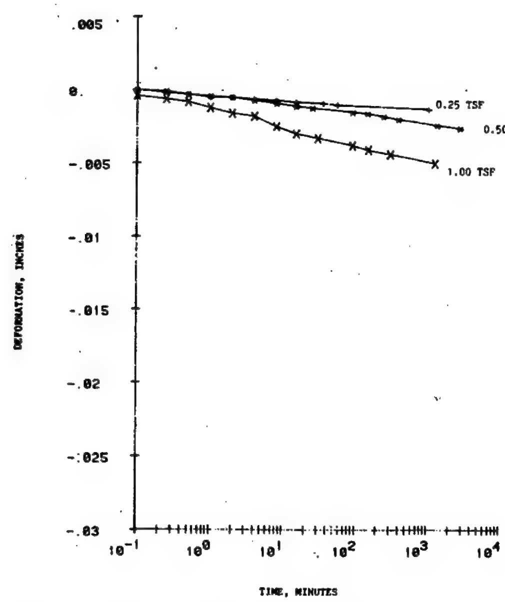
ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE



Type of Specimen UNDISTURBED		Before Test			After Test	
Diam 4.29 in.	Ht 1. in.	Water Content, w_o	28.4	%	w_f	19.9 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	.59		e_f	.54
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	94.	%	S_f	100. %
Compression Index, C_c		Dry Density, γ_d	108.2	lb/ft^3		
Classification Sandy lean clay, CL		k_{20} at e_o = x 10^{-} cm/sec				
LL 44	G_s 2.7	Project CHASKA NCS-IA-84-4-ED-GH				
PL 17	D_{10}					
Remarks		Area MRD LAB NO: 84/54				
		Boring No. 85-52		Sample No. 5		
		Depth Elev 30.0-31.0		Date 27 DEC 1983		
		CONSOLIDATION TEST REPORT				

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE

Figure 2



PROJECT: CHASKA NCS-IA-84-4-ED-GH

MRD LAB NO: 84/34

DATE: 27 DEC 1983

BORING NO: 85-52 SAMPLE NO: 5

DEPTH/ELEV: 30.0-31.0

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

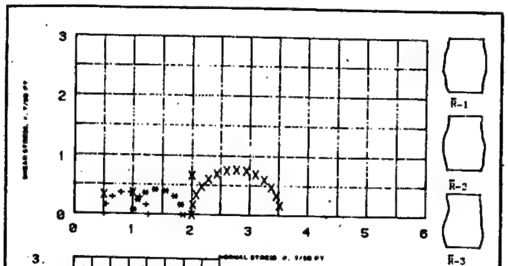
CONSOLIDATION TEST—TIME CURVES

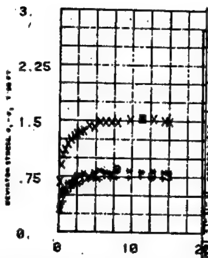
FIGURE: 3

MRD Form 956, 1 May 80

MRD

E F G H J





SPECIMEN NO		1	2	3	
INITIAL: WATER CONTENT, %	w_o	29.8	33.0	29.2	
INITIAL: DRY DENSITY LB/CU FT	γ_{d_o}	95.8	89.6	94.6	
INITIAL: SATURATION, %	S_o	100.	100.	100.	
INITIAL: VOID RATIO	e_o	.78	.86	.75	
BEFORE SHEAR: WATER CONTENT %	w_c	27.7	29.5	24.5	
BEFORE SHEAR: DRY DENSITY LB/CU FT	γ_{d_c}	94.1	91.6	98.8	
BEFORE SHEAR: SATURATION %	S_c	97.	97.	98.	
BEFORE SHEAR: VOID RATIO	e_c	.78	.81	.68	
FINAL BACK PRESSURE, T/SQ FT	u_b	1.9	1.9	1.9	
MINOR PRINCIPAL STRESS, T/SQ FT	σ_3	.5	1.	2.	
MAXIMUM DEVIATOR STRESS, T/SQ FT	$(\sigma_1-\sigma_3)_{max}$	.768	.849	[illegible]	
TIME TO $(\sigma_1-\sigma_3)_{max}$, MIN	t_f	1000	720	900	
ULTIMATE DEVIATOR STRESS, T/SQ FT	$(\sigma_1-\sigma_3)_{ult}$	.75	.811	1.49	
INITIAL DIAMETER IN	D_o	1.89	1.4	1.4	
INITIAL HEIGHT IN	H_o	5.	2.99	5.	

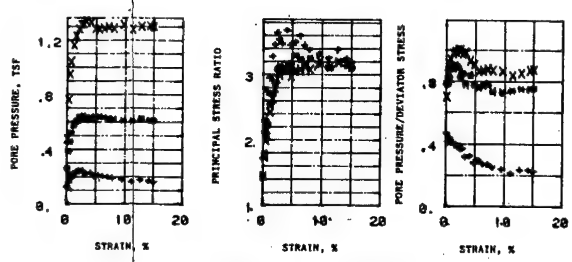
CONTROLLED-STRAIN TEST

DESCRIPTION OF SPECIMENS Sandy clay, CL

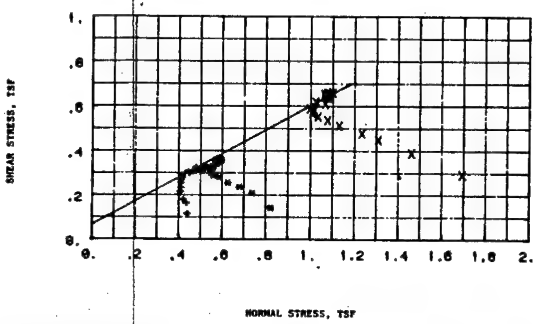
LL 32 PL 13 PI 19 Gs 2.68	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST R̄
REMARKS Low shear strength of R̄-2 may be due to material variation and lower density.	PROJECT CHASKA NCS-IA-82-128-ED-GN !	
	BORING NO 82-50	SAMPLE NO 2
	DEPTH ELEV 18.-18.	
	LABORATORY 86/87	DATE 08 MAR 1983
B value = 1.00	TRIAXIAL COMPRESSION TEST REPORT	

ENG FORM NO 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 14



EFFECTIVE STRESS VECTOR CURVES ON 45 DEGREE PLANE



REMARKS: COMPUTER PRINT-OUT SYMBOLS SAME AS FORM 2089 R TRIAXIAL TEST: PORE PRESSURE MONITORED DURING SHEAR

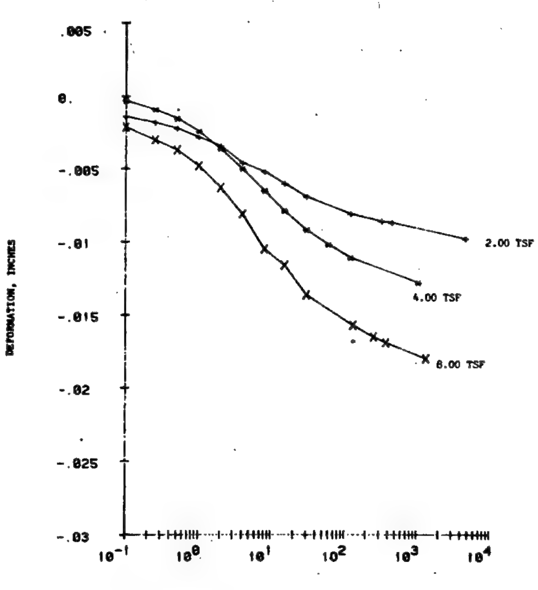
MRD Form 756, 1 May 80

PROJECT: CHASKA NCS-IA-82-128-ED-GN
BORING NO: 82-50 SAMPLE NO: 2
DEPTH/ELEV: 18.-18.
MRD LAB NO: 86/87 DATE: 08 MAR 1983

TRIAXIAL COMPRESSION TEST REPORT

FIGURE: 15

.25 TSF
0.50 TSF
1.00 TSF
10⁴



33
.0-51.0
VES

PROJECT: CHASKA NCS-IA-84-4-ED-GN
MRD LAB NO: 84/34 DATE: 27 DEC 1983
BORING NO: 83-52 SAMPLE NO: 8 DEPTH/ELEV: 88.0-51.0
COMPUTER PRINT-OUT FORMAT SAME AS ENG FORM 2088
CONSOLIDATION TEST--TIME CURVES
FIGURE: 4

MRD Form 956, 1 May 80

SYMBOL	DESCRIPTION	DATE	APPROVAL

SAFETY PAYS

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY: Helen Johnson

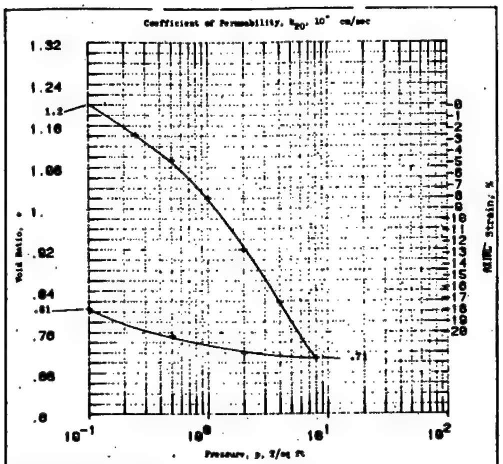
FLOOD CONTROL FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
TRIAXIAL TEST BORING 82-50M
CONSOLIDATION TEST BORING 83-52M

APPROVED: Peter A. Fischer
DATE: OCT 1984
SCALE:
DRAWING NUMBER M34-CH-R-5/153
SHEET OF

2

E F G

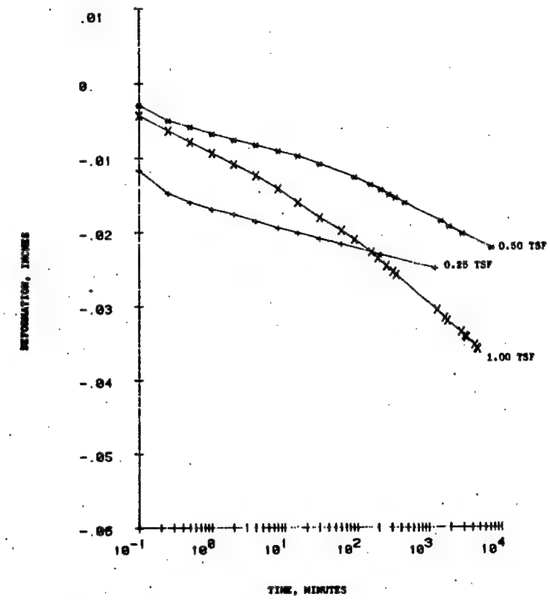
PLATE B-8



Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 4.38 in.	Ht .999 in.	Water Content, w_o	[illegible] %	w_f	[illegible] %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	1.2	e_f	.81
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	97 %	S_f	95 %
Compression Index, C_c		Dry Density, γ_d	71 lb/ft^3		
Classification Sandy peat, OH		k_{20} at e_o = x 10^{-} cm/sec			
LL	G_s 2.5	Project [illegible]			
PL	D_{10}				
Remarks Sample may be disturbed		Area NRD LAB NO: 82/110			
from sampling or handling. Most		Boring No. 82-57M		Sample No. 1	
deformation appears to be secon-		Depth El		Date 01 JUL 1982	
dary compression.		CONSOLIDATION TEST REPORT			

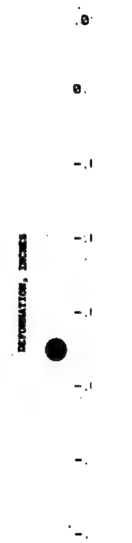
ENG FORM 2090 PREVIOUS EDITIONS ARE OBSOLETE

Figure 2



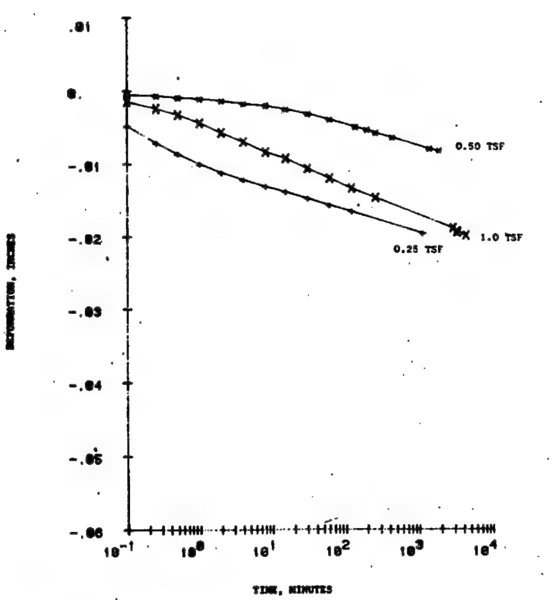
PROJECT: [illegible]
NRD LAB NO: 82/110
BORING NO: 82-57M SAMPLE NO:
DATE: 01 JUL 1982
DEPTH/ELEV:
COMPUTER PRINT-OUT FORMAT SAME AS ENG FORM 2088
CONSOLIDATION TEST—TIME CURVES
FIGURE: 3

NRD Form 956, 1 May 80



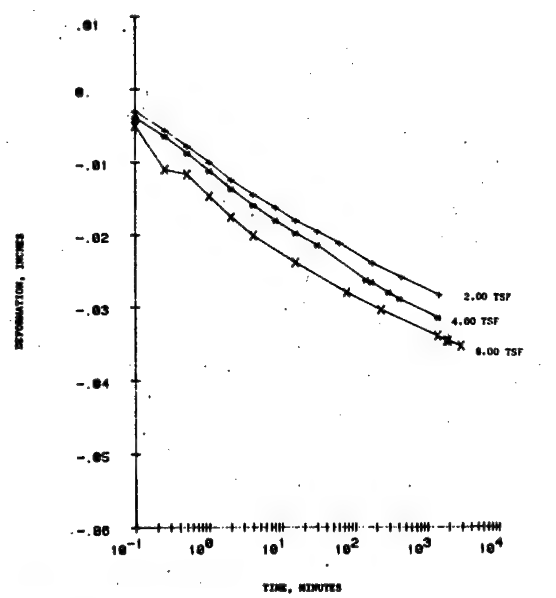
PROJECT:
NRD LAB NO:
BORING NO:
COMPUTER PRIN
SAME AS ENG F

NRD Form 956, 1 May



PROJECT: [illegible]
NRD LAB NO: 88/07
BORING NO: 82-58MU SAMPLE NO: 2
DATE: 24 MAR 1983
DEPTH/ELEV: 18.8-18.8
COMPUTER PRINT-OUT FORMAT SAME AS ENG FORM 2088
CONSOLIDATION TEST—TIME CURVES
FIGURE: 10

NRD Form 956, 1 May 80



PROJECT: [illegible]
NRD LAB NO: 88/07
BORING NO: 82-58MU SAMPLE NO: 2
DATE: 24 MAR 1983
DEPTH/ELEV: 18.8-18.8
COMPUTER PRINT-OUT FORMAT SAME AS ENG FORM 2088
CONSOLIDATION TEST—TIME CURVES
FIGURE: 11

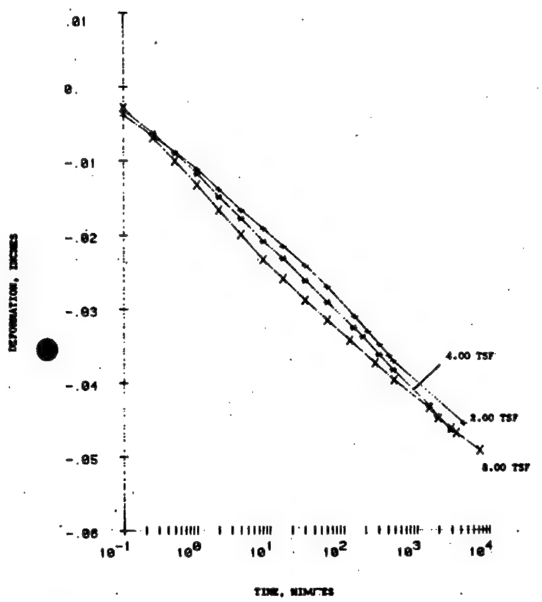
NRD Form 956, 1 May 80

PROJECT:
NRD LAB NO:
BORING NO:
COMPUTER PRI
SAME AS ENG

NRD Form 956, 1 May

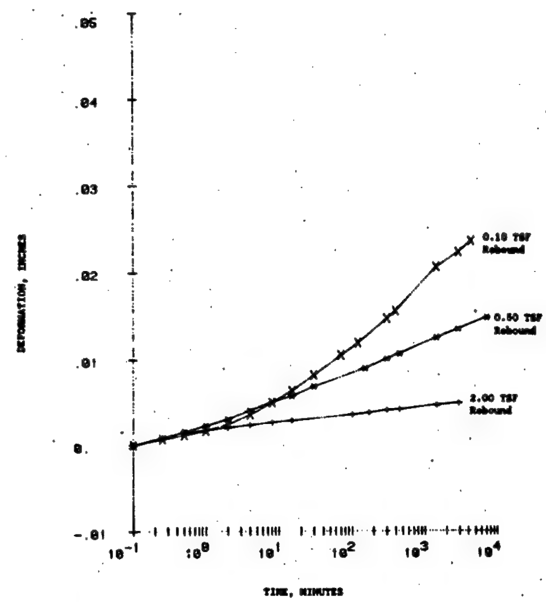
JUL 1982

E CURVES



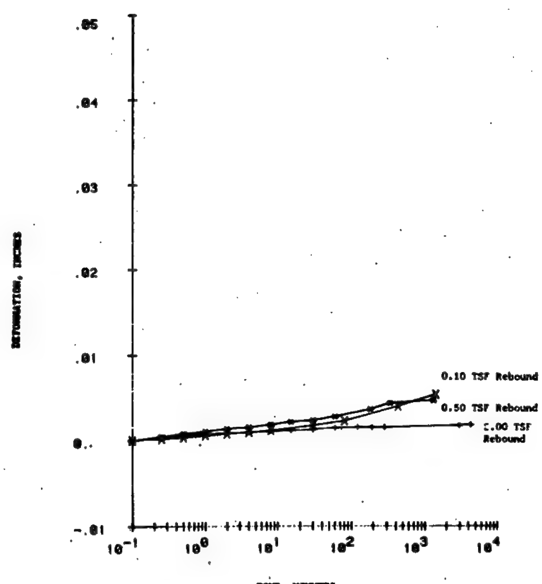
PROJECT: CHASKA MCS-IA-82-56-ED-GM
NRD LAB NO: 82/118
BORING NO: 82-37M SAMPLE NO: 1
DATE: 01 JUL 1982
DEPTH/ELEV:
COMPUTER PRINT-OUT FORMAT SAME AS ENG FORM 2088
CONSOLIDATION TEST—TIME CURVES
FIGURE: 4

NRD Form 956, 1 May 80



PROJECT: CHASKA MCS-IA-82-56-ED-GM
NRD LAB NO: 82/118
BORING NO: 82-37M SAMPLE NO: 1
DATE: 01 JUL 1982
DEPTH/ELEV:
COMPUTER PRINT-OUT FORMAT SAME AS ENG FORM 2088
CONSOLIDATION TEST—TIME CURVES
FIGURE: 5

NRD Form 956, 1 May 80



PROJECT: CHASKA MCS-IA-82-128-ED-GM
NRD LAB NO: 85/67
BORING NO: 82-50MU SAMPLE NO: 2
DATE: 24 MAR 1983
DEPTH/ELEV: 16.8-18.8
COMPUTER PRINT-OUT FORMAT SAME AS ENG FORM 2088
CONSOLIDATION TEST—TIME CURVES
FIGURE: 12

NRD Form 956, 1 May 80

SAFETY PAYS

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

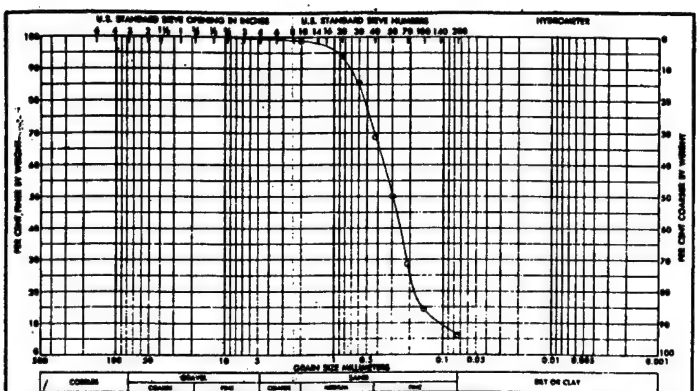
FLOOD CONTROL FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
GRADATION TEST
BORINGS 82-37M & 82-50M

SUBMITTED BY:
APPROVED:
DATE: OCT 1984

DRAWING NUMBER
M34-CH-R-5/154
SHEET OF

2

PLATE B-9

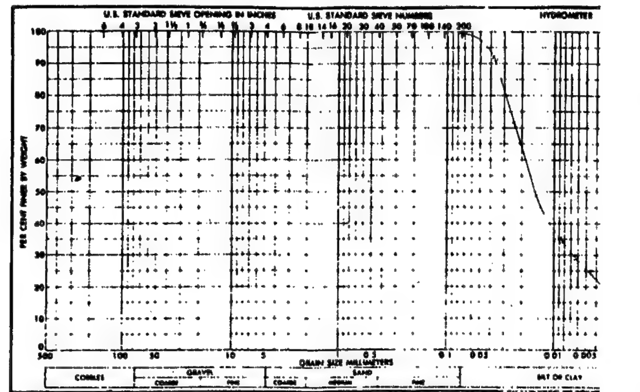


Sample No	Elev or Depth	Classification	Nat W%	LL	PL	PI
3/3Y75	12.0-14.5'	SAND (SP-SM)		Visual		

Project: Chaska Flood Control
Area:
Boring No: 73-5M
Date: May 73

GRADATION CURVES

ENG FORM 1 MAY 63 2087

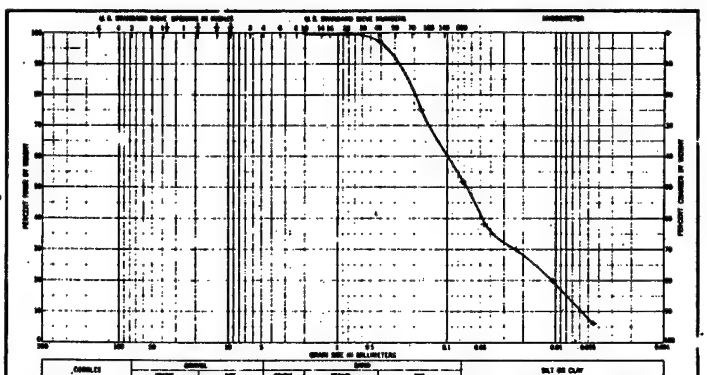


Sample No	Elev or Depth	Classification	Nat W%	LL	PL	PI
9 3Y76	27.0 [illegible]	CLAY (CL)		34	9	5

Project: Chaska Floo[illegible]
Area:
Boring No: 73-5M
Date: May 73

GRADATION CURVES

ENG FORM 1 MAY 63 2087



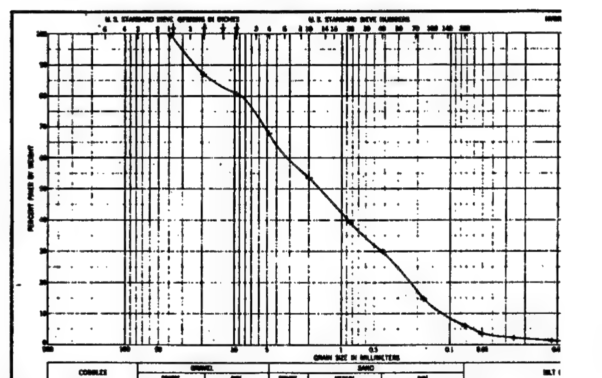
Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
2	18.-18.	Sandy clay, CL		32	13	19

Project: CHASKA NCS-IA-82-128-ED-GH
Area: MRD LAB NO. 88/27
Boring No. 82-58
Date: 08 MAR 1983

GRADATION CURVES

ENG FORM 1 MAY 63 2087

FIGURE 16

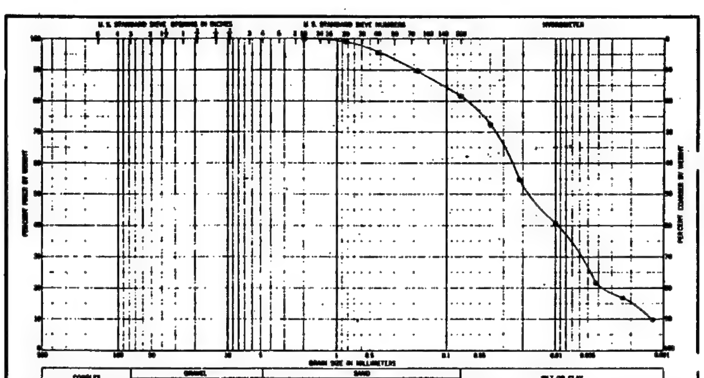


Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
1	5.8-9.2	Gravelly sand, SP-SM				

Project: CHASKA
Area: MRD LAB
Boring No. 85-52
Date:

GRADATION CURVES

ENG FORM 1 MAY 63 2087



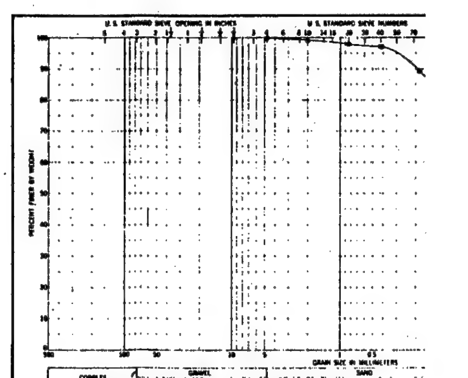
Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
1	17.0-19.0	Clayey silt, MH		81	37	44

Project: Chaska NCS-IA-84-4-ED-GH
Area: MRD Lab No. 84/34
Boring No. 83-53
Date: 27 DEC 1983

GRADATION CURVES

ENG FORM 1 MAY 63 2087

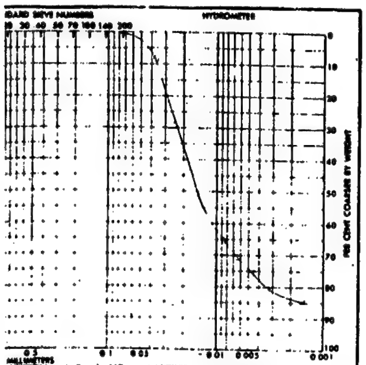
Figure 13



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL
2	26.0-28.0	Sandy organic, OH		207	74

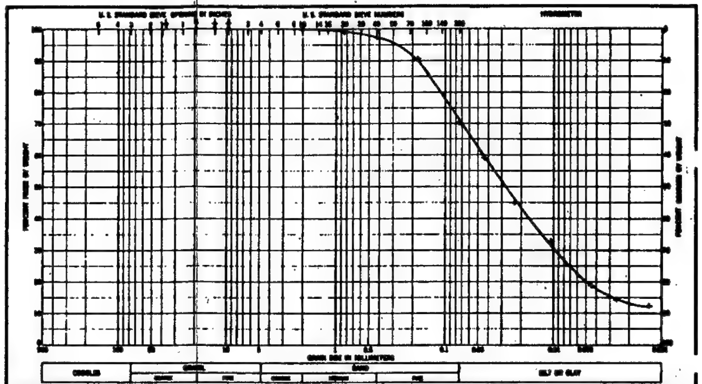
GRADATION CURVES

ENG FORM 1 MAY 63 2087



LL	PL	PI
34	9	5

Project: Chaska Flood Control
Boring No. 73-5M
Date: May 73



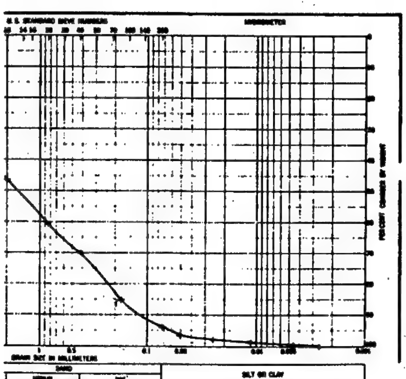
Sample No.	Depth	Classification	Nat w %	LL	PL	PI
1	21.0-22.0	Sandy clay, CH		51	18	33

Project: CHASKA FLOOD CONTROL
NCS-IA-80-118-ED-HF
Area: MRD LAB NO. 80/227
Boring No. 80-38M
Date: 18 DEC 1980

GRADATION CURVES

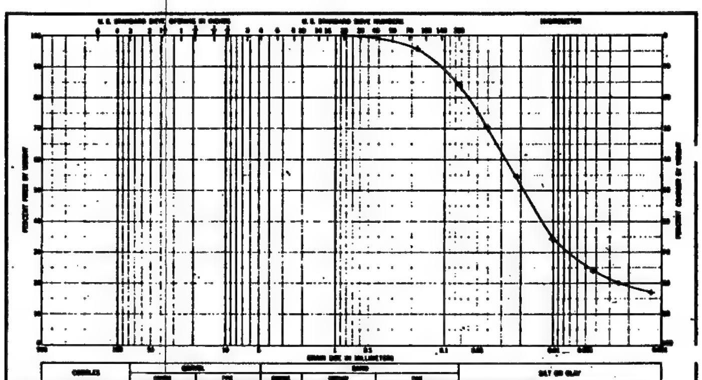
ENG FORM 1 MAY 63 2087

FIGURE 10



Project: CHASKA NCS-IA-84-4-ED-CH
Area: MRD LAB NO. 84/34
Boring No. 83-52
11 JAN 1984

FIGURE 1



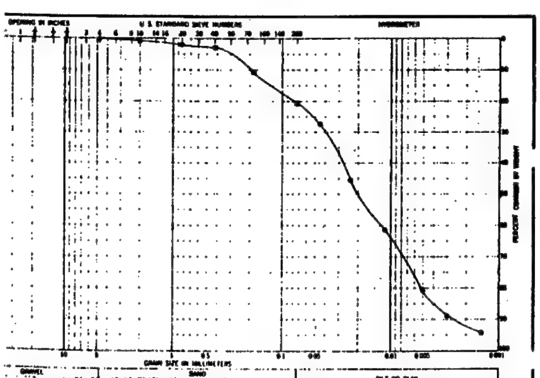
Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
8	58.0-61.0	Lean clay, CL		31	15	16

Project: CHASKA NCS-IA-84-4-ED-CH
Area: MRD LAB NO. 84/34
Boring No. 83-55
11 JAN 1984

GRADATION CURVES

ENG FORM 1 MAY 63 2087

FIGURE 3



Classification	Nat w %	LL	PL	PI
Sandy organic, OH		207	74	133

Project: Chaska NCS-IA-84-4-ED-CH
Area: MRD Lab No. 84/34
Boring No. 83-53
Date: 27 DEC 1983

GRADATION CURVES

Figure 15

2

SYMBOL	DESCRIPTION	DATE	APPROVAL

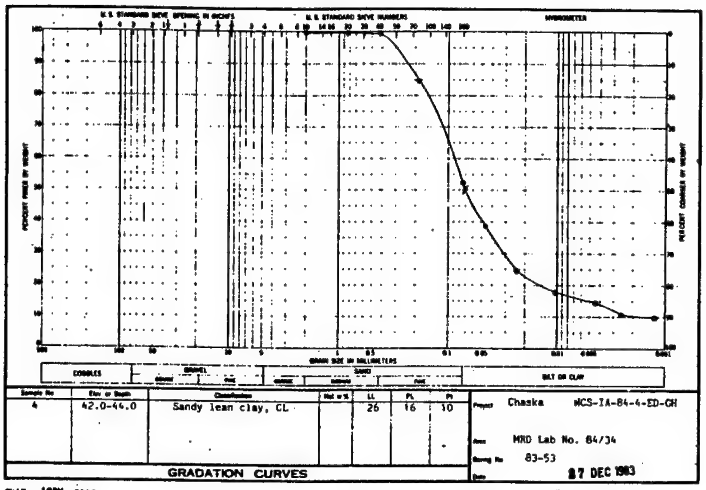
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY:

FLOOD CONTROL FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
GRADATION CURVES
BORINGS 73-5M THRU 83-55M

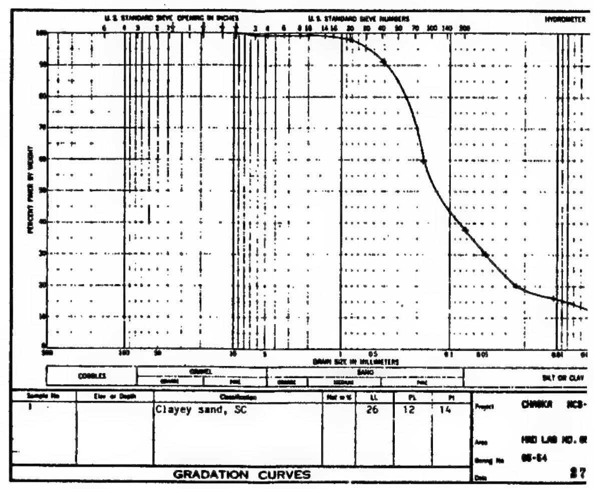
APPROVED:
DATE: OCT 1984
SCALE: AS SHOWN
DRAWING NUMBER M34-CH-R-5/156
SHEET OF

PLATE B-10

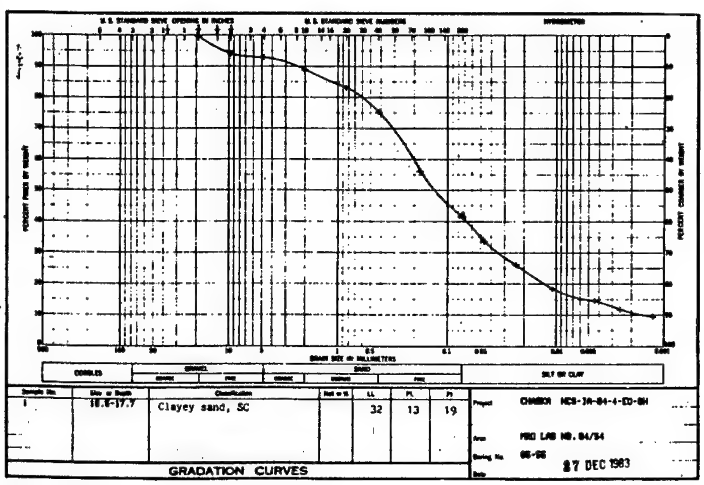


ENG FORM 2087

Figure 17



ENG FORM 2087

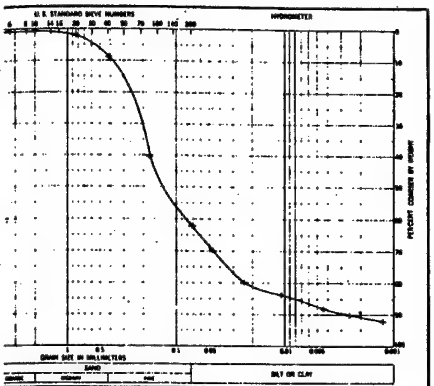


ENG FORM 2087

FIGURE 23

*U.S. GPO 564-055/10034

E F G H J

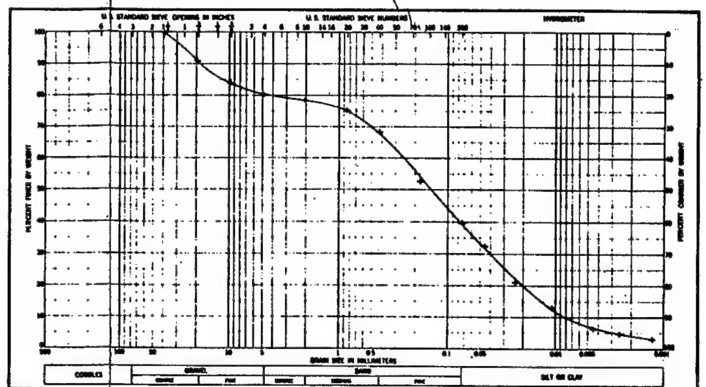


	Nat w %	LL	PL	PI
		26	12	14

Project: CHASKA MCS-IA-84-4-ED-BH
Area: MRD LAB NO. 86/84
Boring No.: 83-54
Date: 27 DEC 1983

RVES

FIGURE 21



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
2	16.6-17.7	Gravelly clayey sand, SC		19	11	8

Project: CHASKA MCS-IA-84-4-ED-BH
Area: MRD LAB NO. 84/84
Boring No.: 83-56
Date: 11 JAN 1984

GRADATION CURVES

ENG FORM MAY 63 2087

FIGURE 7

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY: Helmer Johnson — CHIEF, ED-GD BRANCH
APPROVED: Peter A. Fischer — CHIEF ENGR. DIVISION

FLOOD CONTROL FEATURE DESIGN MEMORANDUM
CHASKA, MINNESOTA
GRADATION CURVES
BORINGS 83-53M THRU 83-56M

DATE: OCT 1984
SCALE:
SPEC. NO.
DRAWING NUMBER M34-CH-R-5/157
SHEET OF

2

E F G

APPENDIX C

STRUCTURAL DESIGN

APPENDIX C

STRUCTURAL DESIGN

TABLE OF CONTENTS

APPENDIX C

STRUCTURAL ANALYSIS & DESIGN

PURPOSE

1. This appendix describes the methods used in the analysis and design of the various channel and bridge structures for the Chaska Creek Flood Control Project, Chaska, Minnesota.

2. It also summarizes structural references, design criteria, assumptions, loading conditions and results. The structures included are the stilling basin, various supercritical channel sections, ogee spillway, subcritical channel section, inlet structure, several drainage channel sections and four bridges. The drainage channel sections include a side inlet structure, a box channel section, an open transition section, and a drop structure. The four bridges include street bridges at 1st Street, Hickory Street, and Hillside Drive and a railroad bridge 100' north of 1st Street.

REFERENCES

3. The applicable sections of the following references were used to formulate design criteria and to determine allowable stresses in the various structures:

a. Technical Report SL-80-4, Strength Design for Reinforced Concrete Structures, Reports 1, 2, and 3. (July 1980, December 1981, and January 1982, respectively).

b. EM 1110-1-2101, Working Stresses for Structural Design (November 1963).

c. EM 1110-2-2000, Standard Practice for Concrete (September 1982).

d. EM 1110-2-2101, Waterstops (April 1970).

e. EM 1110-2-2103, Details of Reinforcement - Hydraulic Structures (May 1971).

f. EM 1110-2-2906, Design of Pile Structures and Foundations (July 1969).

g. EC 1110-2-510, Draft of Engineering Manual, Retaining and FloodWall (August 1983).

h. ETL 1110-2-256, Sliding Stability for Concrete Structures (June 1981).

i. ETL 1110-2-236, Paved Concrete Flood Control Channels (June 1978).

j. ETL 1110-2-265, Strength Design Criteria for Reinforced Concrete Hydraulic Structures (September 1981).

k. EM 1110-2-2300, Structural Design of Spillways & Outlet Structures (November 1983).

l. ACl 318-83, Building Code Requirements for Reinforced Concrete (November 1983).

m. AASHTO Standard Specification for Highway Bridges (12th Edition, 1977 with current Interim Specifications).

n. AREA 1983-84 Manual for Railway Engineering (Copyright 1983).

o. Engineering Monograph No. 27, Moments and Reactions for Rectangular Plates, by W.T. Moody, U.S. Bureau of Reclamation.

p. Timber Construction Manual (Second Edition, 1974).

CRITERIA, LOADS, METHODS

DESIGN CRITERIA & ASSUMPTIONS

4. The major structural design criteria and assumptions that were used throughout this project are listed below. Design criteria not used universally will be noted with the applicable specific structure(s). All assumptions relative to soil properties are further documented in the geotechnical appendix and calculations.

a. Allowable concrete stress (F'c) = 4000 p.s.i.

b. Grade 60 steel reinforcement will be utilized throughout this project. Ultimate allowable steel stress (Fy) = 48,000 p.s.i.

c. Unit weights assumed are as follows:

Concrete	150 p.c.f.
Earth Backfill	130 p.c.f.
Water	62.5 p.c.f.

d. Modulus of subgrade reaction (Ks) = 400 k.c.f.

e. Lateral earth pressures assumed as follows:

	Level	2:1 Max Slope
Active (Ka)	0.33	0.53
At Rest (Ko)	0.50	1.03
Passive (Kp)	3.00	7.44

f. Max earth backfill slope is 2:1

g. Required lateral displacement in wall to reach fully mobilized lateral earth pressure state:

Passive	Displacement = 0.02 x H
Active	Displacement = 0.005 x H

h. Minimum uplift stability safety factor = 1.15

The minimum Factor of Safety of 1.15 for uplift is based on a worst case condition that the soil is only 6 feet above the invert (i.e. 3.3' of bare wall showing) and that the weephole drains are only 50% effective so that the groundwater level is five feet above the invert. The actual design case would be soil to the top of the wall and groundwater at the level of the weepholes. The Factor of Safety against uplift for this case is 3.30. The Factor of Safety against uplift for an intermediate condition of soil to the top of the wall and groundwater 5 feet above the invert is 1.52. All the Factors of Safety given in the text are for the worst case condition.

i. Minimum sliding stability safety factor = 1.50

j. Max joint spacing as follows:

Contraction Joint	40 feet
Expansion Joint	120 feet

k. Minimum wall thickness = 1'-4"

l. Impact forces due to flowing water, turbulence, waves, etc. and due to floating debris or ice are determined to be insignificant. These insignificant forces will be neglected.

m. Minimum steel reinforcement cover is 2". All concrete surfaces cast against earth or in contact with channel water shall have 3" minimum cover.

n. Minimum shrinkage and temperature reinforcement ratio to be provided as follows:

Unrestrained Members	0.002 (Half in each face w/ #6 @ 12" Max.)
Restrained Members	0.004 (Half in each face w/ #9 @ 12" Max.)

o. Drainage system along channel assumed to be 50% effective.

p. Safety fencing is to be used to eliminate all hazardous conditions. Fence posts will be embedded in the top of concrete walls.

Fence forces on structure are insignificant and will be neglected

q. The recommended seepage control and frost protection design is shown on Plate 27. It includes 2 inches of Styrofoam RM insulation and 1.5 feet of free-draining gravel material underneath and behind the insulation. A cost comparison was made between various thickness combinations of insulation and gravel, all of which provided the same degree of frost protection, and it was found that the above combination was the most cost efficient.

The frost penetration design was based on a design freezing index of 2600 degree days which will permit frost to penetrate below the free-draining gravel into the native frost susceptible material for a distance of 6 inches. In other words, 2.0 feet of free-draining gravel would be required to prevent frost from penetrating into the native frost susceptible material. However 1.5 feet of free-draining gravel is adequate for this design for the following reasons:

(1) The 4 inches of sand was not included in the calculations. When the sand is included it decreases the frost penetration into the frost susceptible material from 6 inches to 2 inches.

(2) If the frost does penetrate 2 inches into the frost susceptible material and causes an expansion of 9%, the frost heave will be .18 inches.

(3) The channel monoliths will be keyed together so that any differential frost heave forces will not cause differential movements at the monolith joints.

(4) Even if keys were not provided it is hydraulically acceptable to have minor differential vertical movement of the monoliths at the joints.

(5) Ground water flows through the gravel layer during the winter will tend to provide a convective heat transfer mode thereby decreasing the frost penetration depth.

(6) Effects of snow cover in the channel at various times during the winter will tend to decrease the frost penetration depth.

ANALYSIS METHOD

5. Each of structures in this project was analyzed as a rigid frame cast-in place reinforced concrete structure. It is assumed that these structures obey the theory of elasticity. Plastic theory analysis was not performed.

6. All structures, except those on piles, are modeled as a beam on an elastic foundation. This technique is derived from the concept of the Winkler Foundation, consisting of a series of truss members (springs) supporting the base of the structure. It assumes a stepped soil pressure distribution which acts through the various truss members. Each truss member has a modulus of elasticity, area, and length which

provide a similar reaction to that of the in-situ soil foundation. Throughout this project, a computer software package, PFRAME, by Struct-Soft, Inc., was utilized to perform matrix structural analysis. The shears, moments, deflections, and soil pressures required to design the structure are computed by this program. The side walls, base, slab, and top slab are designed to act together continuously to produce a unique distribution of foundation reactions or soil pressure.

7. With this program, it was necessary to "cut" truss members which are in tension and re-run the analysis until all truss members are in compression. This is necessary to accurately model a cohesionless soil foundation, which has negligible tensile strength.

8. All structures have also been analyzed with regard to uplift and sliding stability using techniques derived from the field of statics.

LOAD TYPE AND COMBINATIONS

9. In general, all of the possible unfactored load types for each individual structure were first derived and input into the PFRAME program. The computer output included unfactored joint displacements, member end outputs and support actions. The critical unfactored deflections and soil pressures were calculated in the structural calculations from these results.

10. Then, all of the possible load combinations for each structure were derived and input with load factors into the PFRAME program. This program creates an envelope of forces and moments from the possible load combinations. Additonal computer output includes the absolute maximum axial forces, moments and shear forces at numerous points along each of the members.

11. In general, each structure had the following load types: Dead load, interior maximum loading, exterior unsaturated soil loading and exterior saturated soil loading plus uplift. Each structure typically had the following load combinations: Dead load + interior maximum loading, dead load + exterior unsaturated soil loading, and dead load + exterior saturated soil loading plus uplift. Bridge structures also included a superimposed live load type and additional load combinations. For further information, the load types and combination for each structure in this project are fully documented in the structural calculations.

DESIGN METHOD

12. The ultimate strength method of design was utilized on all structures on this project. In general, the load factor for dead load was 1.4 and for live load was 1.9. The live load factor for the superimposed bridge loads was 2.17 on highway bridges and 2.33 on the railroad bridge, as required by AASHTO and AREA, respectively.

Throughout this project, the strength reduction factors of 0.9 for moments (with or without axial forces) and 0.85 for shears was used.

13. Allowable moments were found through use of the tables in T.R. SL-80-4, Report 2 (Reference 2.a). Allowable shear forces were computed with formulas in A.C.I. 318 (Reference 3.j).

STRUCTURES

STILLING BASIN

14. The stilling basin is the most downstream of all the concrete structures on this project. It is located from Sta. 21+82 to Sta. 22+55. The structure is approximately 37.5' wide, 24' high, and 72.5' long. Features of this structure include an 11' high parabolic drop, seven 4' high chute blocks, six 4' high baffle blocks and a 1.5' high end sill. The walls of the stilling basin are tapered from 3'-6" at the base of the structure to 1'-4" at the top. Tapered walls were determined to be more economical than constant 3'-6" wide walls. The base slab is 3'-6" thick. This structure is shown on drawing number M34-CH-R-5/131.

15. During structural analysis, the assumption was made that the maximum soil loading condition was with backfill level with the top of the walls. Results of this analysis show that the maximum soil bearing pressure is 2863 p.s.f. The maximum wall deflection is 0.38 inches. The stability safety factors are 1.35 for uplift and 3.33 for sliding. The maximum reinforcement required is #10 @ 6". Shear reinforcement is not required.

SUPERCRITICAL CHANNEL

16. The supercritical channel design section begins immediately upstream of the stilling basin and continues up to the ogee spillway, except at bridge locations. This reach of the project extends from Sta. 22+55 to Sta. 62+45. It includes both straight alignment sections and superelevated curved alignment sections. The design section is either 35' or 37.5' wide, 9'3" high and approximately 3990' long. This structure is shown on drawing number M34-CH-R-5/132.

17. In the supercritical channel design calculations, member sizes were determined which minimized concrete volume while still meeting the structural design criteria. Concrete walls 1'-4" thick with a 2'-0" thick base slab with 4'-0" slab extensions on both sides was found to be the most economical section.

18. Results of the final supercritical channel design include a maximum soil bearing pressure of 1206 p.s.f., a maximum top of wall deflection of 0.05 in., an uplift safety factor of 1.19 and a sliding safety factor of 2.35. The sliding stability analysis was based upon one wall backfilled to the top with a 2:1 backslope and the other backfilled level 3' below the top of the wall. The maximum reinforcement required for bending at the base of the wall is #9 @ 12". Shear reinforcement is not required.

SUPERCRITICAL CHANNEL AT HWY. 212 BRIDGE

19. The existing Highway 212 Bridge has a prestressed concrete bridge deck with cast-in-place concrete abutments and footings, supported on piling. The clear distance between abutments is 45' and between footings is 39'. The standard supercritical channel section is 45'-8" wide to the outside of the standard base slab extensions. In addition, the channel alignment in this area is curved while the bridge abutments are straight. Therefore, it was necessary to reduce the base slab width and taper the base slab bottom outside corners to allow the channel to geometrically fit through the existing bridge opening. In doing so, though, it was necessary to thicken the base slab to maintain uplift resistance.

20. This special supercritical channel section at this Highway 212 Bridge occurs at approximately Sta. 56+01. The channel section is 35' wide, 9'3" high and 70' long. A cross section of this special section may be viewed on drawing number M34-CH-R-5/132.

21. Design of this structure yields a maximum soil bearing pressure of 913 psf and a maximum top of wall deflection of 0.04 in. The base slab thickness was designed to provide an uplift safety factor of 1.15. Sliding stability is satisfied due to symmetrical lateral soil loading. The maximum required wall reinforcement for bending is #9 @ 12". Shear reinforcement is not required.

OGEE SPILLWAY AND SUBCRITICAL CHANNEL

22. The ogee spillway structure functions as the transition section from subcritical to supercritical flow. It features a low ogee crest to provide this transition and is located from Sta. 62+45 to Sta. 62+73. The spillway structure is 35' wide, 27.1' high, and 29' long.

23. Immediately upstream of the ogee spillway is the subcritical channel. It reaches from Sta. 62+73 to Sta. 63+73. This channel section is 35' wide, 17.7' high and 98' long. Both the ogee spillway and the subcritical channel are shown on drawing number M34-CH-R-5/133.

24. Design parameters of the subcritical channel and the ogee spillway are similar. Both structures are located far enough upstream so that uplift is not a critical concern. Both structures are backfilled from 15' to 20' above the top of the base slab at the critical section. Both structures need to have 2' thick base slabs and walls.

25. A structural model was run of the subcritical channel. It resulted in a maximum soil bearing pressure of approximately 2100 psf, a maximum top of wall deflection of 0.11 in., and a maximum wall reinforcement of #10 @ 8". Uplift stability was satisfied and shear reinforcement is not required.

26. These results were then modified proportionally due to slightly greater maximum wall backfill height on the ogee spillway. The maximum soil pressure, wall deflection, shears and moments were increased inconsequentially. Therefore, the same structural design as the subcritical channel will be used for the ogee spillway. In addition, spillway sliding stability was investigated and found to have a safety

factor against sliding of 17.6.

INLET STRUCTURE

27. The inlet structure is located from Sta. 63+73 to Sta. 64+34, immediately upstream of the subcritical channel section. It is the most upstream concrete structure in this project and features a smooth transition from a trapezoidal, riprapped channel with 1 on 3 side slopes to the rectangular, concrete subcritical channel. The structure is 35' wide at the base, 155' wide total, 17.7' high and 60' long. It is shown with both plan and section views on drawing number M34-CH-R-5/134.

28. The most difficult task in designing this structure was to develop an economical arrangement of form work while minimizing concrete volume. From a constructability view point, it was determined that a flat base slab would be constructed first. Then, vertical walls along the outside edges of the structure would need to be constructed in the steeply tapered wall regions of the inlet channel. This would consist of a wall starting at the subcritical channel, extending to a poiint where the tapered wall has a 1:1 slope, and continuing down to a point at the upstream end of the structure where the flat base slab and the 1 on 3 slope meet. The third step would be to grout in the desired steep side slopes in lifts as required to prevent the uncured grout from flowing. Thereafter, this portion of the structure would be backfilled. The final step in the inlet structure construction sequence would be to pour the less steep tapered walls as inclined slabs-ongrade with a hinged connection to the vertical walls.

29. Due to the geometry of the structure and to the massive concrete sections that are required for constructability of this complex structure, minimal reinforcement is required in the grouted areas of the structure. Likewise, the base slab and the inclined slab-on-grade will also be minimally reinforced. It was determined that the base slab, vertical walls and inclined slab-on-grade should all be 12" thick.

DRAINAGE CHANNEL

30. The drainage channel is a smaller rectangular concrete channel which routes storm water flow from two existing 60" C.M.P. culverts to the main channel. This smaller channel is located between 1st Street and Hickory Street. Its main channel approximate station is 42+00.

DRAINAGE CHANNEL SIDE INLET

31. Through the side inlet, the drainage channel flows into the side of the main channel. Here, the flow in the two channels is nearly parallel and flow from the drainage channel enters the main channel smoothly and uniformly. Along the 120' length of the side inlet, the main channel gradually changes width from 35' wide upstream to 37.5' wide downstream due to the increased main channel flow.

32. The side inlet channel tapers from 9' wide to 1.5' wide, is 8.5' high, and 120' long. This structure is located at drainage channel station 0+00 to Sta. 1+20. A plan and cross section of this is shown on

drawing number M34-CH-R-5/135.

33. Results of the structural analysis show a maximum soil pressure of 2379 p.s.f. and a maximum top of wall deflection of 0.07 in. Stability requirements have been met with an uplift safety factor of 1.76 and a sliding safety factor of 1.61. The maximum reinforcement required for bending is #8 @ 12. Shear reinforcement is not required.

DRAINAGE CHANNEL BOX STRUCTURE

34. The drainage channel box structure is located from drainage channel Sta. 1+20 to Sta. 3+75, immediately upstream of the side inlet structure. This closed box structure was necessary to provide driveway access and to prevent destruction of the lawn of a residence along this drainage channel. The height of topsoil cover over the top of the channel is assumed to vary up to 3.8' maximum. The structure is 9' wide, 9.5' high and 255' long. A section of this box structure is shown on drawing number M34-CH-R-5/135.

35. The maximum soil pressure under the box structure is 1526 p.s.f. The uplift safety factor is 3.33. Sliding stability is assured due to uniform lateral soil loading. The maximum required reinforcement for bending is #7 @ 12". The walls and base slab are 1'-4" thick and the top slab is 1'-0" thick. Shear reinforcement is not required.

DRAINAGE CHANNEL TRANSITION STRUCTURE

36. Immediately upstream of the box structure, the drainage channel transition structure is located from drainage channel Sta. 3+75 to Sta. 4+25. This structure is an open channel section with a constant 8.4' wall height and a width which funnels from 22' upstream to 9' downstream, where it enters the box structure. This transition occurs in a 50' length. The drainage channel transition structure is shown on drawing number M34-CH-R-5/136.

37. Computer models were run through both the narrowest and the widest section. One transition section design, based upon the most critical moments and shears in these two sections, was used throughout this structure.

38. Design results yield a 2'-6" thick base slab and 1'-4" thick walls. The maximum soil bearing pressure is 998 psf. The maximum wall deflection is 0.08 in. This structure has a 1.46 uplift safety factor. #8 bars @ 12" were the maximum reinforcement required for bending. Sliding stability is assured due to uniform lateral soil loading and shear reinforcements is not required.

DRAINAGE CHANNEL DROP STRUCTURE

39. Located from drainage channel Sta. 4+25 to Sta. 4+60, this structure is the most upstream drainage channel structure. It connects to the twin 60" C.M.P. pipes. Flow from these pipes drops 17.5' onto the drop structure base slab. The drop structure is 22' wide and tapers from 25.5' high at the upstream end to 11.3' high at the downstream end.

Both the walls and the base slab are 2'-6" thick. The 35' long drop structure is shown on drawing number M34-CH-R-5/136.

40. This structure was the only structure that was not modeled as a plane frame. Instead, moments and shears were assumed to distribute to the end wall as well as to the base slab. Critical moments and shears were found through the use of U.S. Bureau of Reclamation, Engineering Monograph No. 27, moments and reactions for rectangular plates (July 1970).

41. The critical results are #11 @ 6" maximum reinforcement and an uplift safety factor of 1.78. End wall extensions were required to prevent longitudinal sliding of this structure.

1ST STREET BRIDGE

42. Along the main channel, the 1st Street Bridge is the most downstream bridge. It is located at approximately Sta. 28+80. It features a 32' street width to the face of curbs, a 2' wide walk, steel pipe railing at each side and 4' approach aprons on each end. The channel opening under the bridge is 37.5' wide, approximately 12' high, and 38' long. This bridge has 2'-0" thick walls, a 2'-6" thick top slab and a 3'-0" thick base slab. It is shown on drawing numbers M34-CH-R-5/137 and 5/138.

43. All street bridges were designed on the basis of governing AASHTO design criteria. A HS 20 design loading was used.

44. Due to poor soil conditions, it was necessary to support the 1st Street Bridge on a pile foundation. This pile foundation was designed based upon a gross allowable load per pile of 70,000 lbs. - as recommended by Soil Exploration Company. Each pile is embedded 1'-0" into the bridge base slab.

45. Results of the structural design included a maximum reinforcement for bending of #9 @ 6". Uplift stability is satisfied by comparison with the basic supercritical channel section. Sliding stability is satisfied by uniform lateral soil loading.

RAILROAD BRIDGE

46. The railroad bridge structure is located approximately 100' upstream of 1st Street Bridge, at approximately Sta. 30+00 along the Chicago and Northwestern Railroad.

47. The final configuration of the railroad bridge is based primarily on free board requirements and cost. Initially, a box culvert bridge was proposed which was 37.5' wide, approximately 11.5' high and 104' long. The cost of this structure was very high due to the large quantity of concrete and bearing piles required.

48. A deck beam type bridge was also considered but it was found that the required beams would have low steel such that adequate freeboard would not be provided.

49. Finally, in reviewing bridge plans with similiar spans, a thru girder type bridge with same span which provided adequate freeboard was found. The plans were dated January 1981 and were for the Chicago and Northwestern Railroad. These plans formed the basis for the proposed bridge.

50. The railroad bridge is shown on drawings M34-CH-R-5/137 and 5/138. It consists of two plate girders 7'- 0" tall with an average span of 80'- 0", and a ballasted deck. The bridge deck is supported on abutments which contain 40 bearing piles each. The design of the bridge will be completed during design for plans and specifications.

HICKORY STREET BRIDGE

51. The Hickory Street Bridge is located approximately 1600' upstream of the 1st Street Bridge, from Sta. 44+57 to Sta. 45+09. Like the 1st Street Bridge, the bridge deck is 32' wide from the face of curbs and includes a 2' wide walk and steel pipe railing on each side and a 4' wide approach apron on each end. This bridge is supported on a concrete mat foundation without any piling. The structure is 35' wide, approximately 10' high and 52' long. This bridge has a 2' thick base slab and walls and a 2.5' thick top slab. The drawings of this structure are on drawing number M34-CH-R-5/139.

52. The final maximum soil bearing pressure was 3318 p.s.f. The maximum required reinforcement is #9 bars @ 6". Uplift and sliding stability is satisfied. Shear reinforcement is not required.

HILLSIDE DRIVE BRIDGE

53. Approximately 400' upstream of the Hwy. 212 Bridge, the Hillside Drive Bridge is located at approximately Sta. 59+80. This bridge structure is considerably smaller than the 1st Street and the Hickory Street Bridges, due to considerably less projected traffic volume. The bridge deck is 20' wide from the face of the curbs. The bridge also features a 2' wide walk and steel pipe rails on each side and 4' wide approach aprons on each end. The structure is 35' wide, about 11' high,

and 46' long. The bridge is supported with a concrete mat foundation. This structure is shown on drawing number M34-CH-R-5/140.

54. Even though this Hillside Drive Bridge has a small projected traffic volume, it was designed based upon an HS 20 loading. This resulted in a maximum soil bearing pressure of 3437 p.s.f. Uplift and sliding stability was satisfied. The maximum required concrete reinforcement was #9 at 6" in a 2' thick base slab and walls and a 2.5' thick top slab. Shear reinforcement was not required.

DEBRIS CONTROL STRUCTURE

55. A debris control structure is located at the upstream end of the channel project. The purpose of the structure is to prevent fallen trees and large rocks from entering the channel. The structure consists

of 14" round timber piles at 7 feet on center, driven into the ground in a V-shaped configuration pointing upstream. The purpose of the V-shaped configuration is to deflect debris to the sides to prevent clogging of the structure. A sill to prevent large rocks from entering the channel is constructed at the channel bottom by driving PMA 22 steel sheet piling 10 feet into the ground with 2 feet exposed. See drawing number M34-CH-R-5/125.

56. The timber piles were designed assuming a head differential of 1.2' beginning at the top of the piles. Design for stability and bending were based on an example from the Timber Construction Manual, second edition for a timber pole subjected to a lateral load.

OUTLET A

57. Outlet A consists of a flared end section, a sluice gate well, a flap gate well, 2 manholes with grated tops, an-outlet structure, and approximately 800 linear feet of 60 inch reinforced concrete pipe. Both gate wells were copied from similar gatewells in the Winona Stage 1 flood control drawings. The manhole sare T-type manholes with short riser sections and cast iron gratings. The outlet structure ties into the wall of the concrete channel and has the same reinforcing. The 60 inch reinforced concrete pipe will be Class III with banded joints beneath the levee and Class II everywhere else. See drawing number M34-CH-R-5/123 and 5/124.

SAMPLE CALCULATIONS

58. Calculations are attached for the final design of the typical supercritical channel section. See paragraphs 5 thru 13 for a description of the analysis method, load types and combinations, and design method.

BONESTROO, ROSENE, ANDERLIK & ASSOC., INC. CONSULTING ENGINEERS St. Paul, Minnesota	Client U.S. Corps of Engineers	Page 13
	Project West Creek, Chaska, MN	Proj. No. 11507
Calculations For Supercritical	Prepared By Keith Bachmann	Date 2/17/84
Channel Design	Reviewed By MTR	Date 6/18/84

Final Super Critical Channel Design:

Revised Assumptions (See Sheets 1 & 2)

1-3) OK

4) Max Backfill Angle = 2:1 = 26.5°

Lateral Earth Pressures:	Level	2:1
Ka: Active	0.33	0.53
Ko: At Rest	0.50	1.03
Kp: Passive	3.00	7.44

Req'd Top-of-Wall Lateral Displacement to Reach Fully Mobilized Lateral Earth Pressures:

Active = .005 H

Passive = .02 H

5) Modulus of Subgrade Reaction (ks) = 400 kcf (Medium Dense Sand)

L = 524,160 ksf / 400 kcf = 1310 ft.

6) OK

7) Uniform, Compacted, Granular Backfill Density = 130 pcf

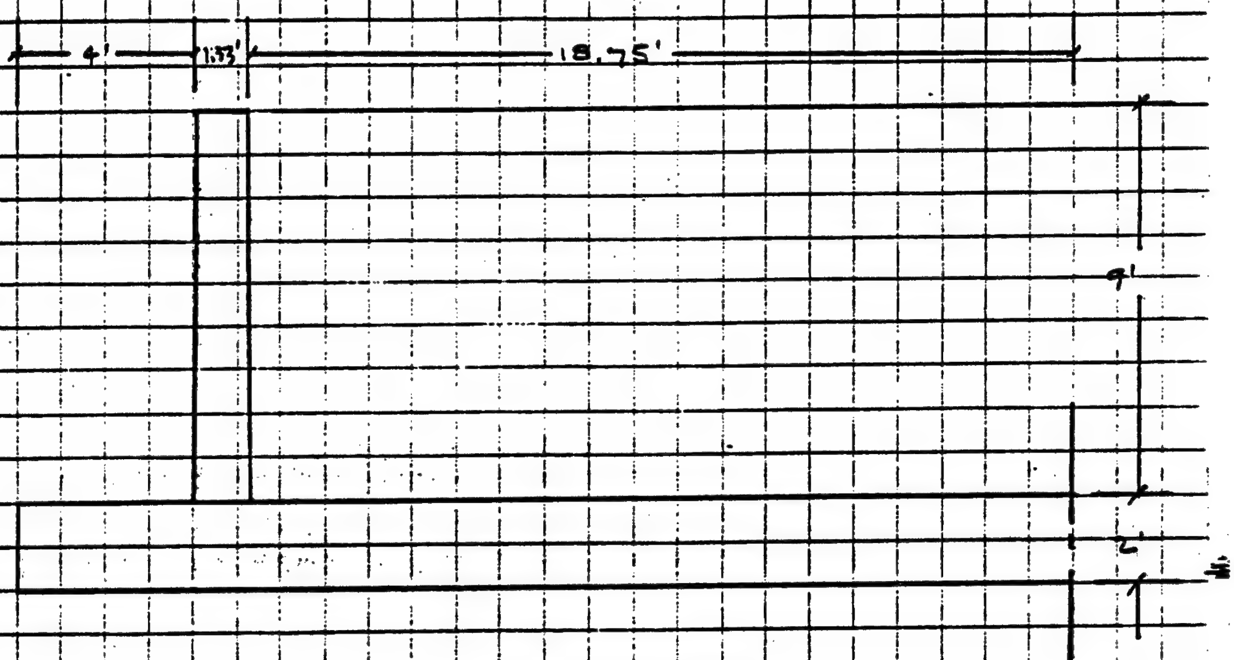
8-10) OK

11) Since Ko for 2:1 Slope ≈ 1, Dry Lateral Earth Pressure ≈ Saturated Lateral Earth Pressure when Ko Applies & 2:1 Sloped Surcharge is Present.

12) Uplift Resistance due to Soil - Trapezoidal X-Section, 6' high - level, Ø min. = 20°

BONESTROO, ROSENE, ANDERLIK & ASSOC., INC. CONSULTING ENGINEERS St. Paul, Minnesota	Client Project	Page 14 Proj. No.
Calculations For	Prepared By Reviewed By	Date Date

Final Super-Critical Channel Geometry



BONESTROO, ROSENE, ANDERLIK & ASSOC., INC.
CONSULTING ENGINEERS
St. Paul, Minnesota

Calculations For	Client	Page 15
	Project	Proj. No.
	Prepared By	Date
	Reviewed By	Date

Load Types:

Type DL: Concrete Weight. (Computer Designation: DEAD LOAD)

Type LL: Interior Full to Top.
Level Granular Backfill to 6' above Channel Invert.
Unsaturated Backfill. No Uplift.
(Computer Designation: LIVE LOAD.)

Type WL: Interior Empty.
Granular Backfill to Top of Wall w/ 2:1 Sloped Surcharge.
Unsaturated Backfill. No Uplift.
(Computer Designation: WIND LOAD)

Type EL: Interior Empty.
Granular Backfill to Top of Wall w/ 2:1 Sloped Surcharge.
Backfill Saturated to 5' above Channel Invert. (Neglect!)
Full Uplift Head.
(Computer Designation: EARTH LOAD)

Load Combinations:

Comb. 1: F = 1.5 DL + 1.9 LL
Comb. 2: F = 1.5 DL + 1.9 WL
Comb. 3: F = 1.5 DL + 1.9 EL

} Factored Shear & Moments.

Computer Model:

Geometry as shown on Sheet 5, except that Y-coordinate of lower joint of truss members (#2 - #13) is changed to -1310 ft. (ks = 400).

Member & Joint Numbers as Shown on Sheet 5.

BONESTROO, ROSENE, ANDERLIK & ASSOC., INC. CONSULTING ENGINEERS St. Paul, Minnesota	Client	Page 16
	Project	Proj. No.
Calculations For	Prepared By	Date
	Reviewed By	Date

Loading Computations:

DL:

Wall DL applied to Joint 17: F = 1.33' x 9' x 150 pcf = 1800 lbs.

Uniform Slab DL applied to Members 14 - 27:

w = 2' x 150 pcf = 300 lb/ft.

LL:

Triangular H2O Load applied from 1' to 10' on Member 1:

Wmax = 9' x 62.5 pcf = - 562.5 lb/ft.

Triangular Soil Load applied 1' to 7' on Member 1:

Wmax = 6' x 130 pcf x 0.5 = 390 lb/ft.

Soil Weight on Ftg. Extension applied to Members 14, 15, & Left ½ of 16:

w = 6' x 130 pcf = 780 lbs/ft.

Lateral Soil Force on End of Footing applied to Joint 3:

F = 7' average x 130 pcf x 0.5 x 2' high = 910 lbs.

WL:

Triangular Soil Load applied from 1' to 10' on Member 1:

wmax = 9' x 130 pcf x 1.03 = 1205.1 lbs/ft.

Soil Weight on Ftg. Extension applied to Members 14, 15, & Left ½ of 16:

w = 10' ave x 130 pcf = 1300 lbs/ft.

Lateral Soil Force on End of Footing applied to Joint 3:

F = 12' average x 130 pcf x 1.03 x 2' high = 3213.6 lbs.

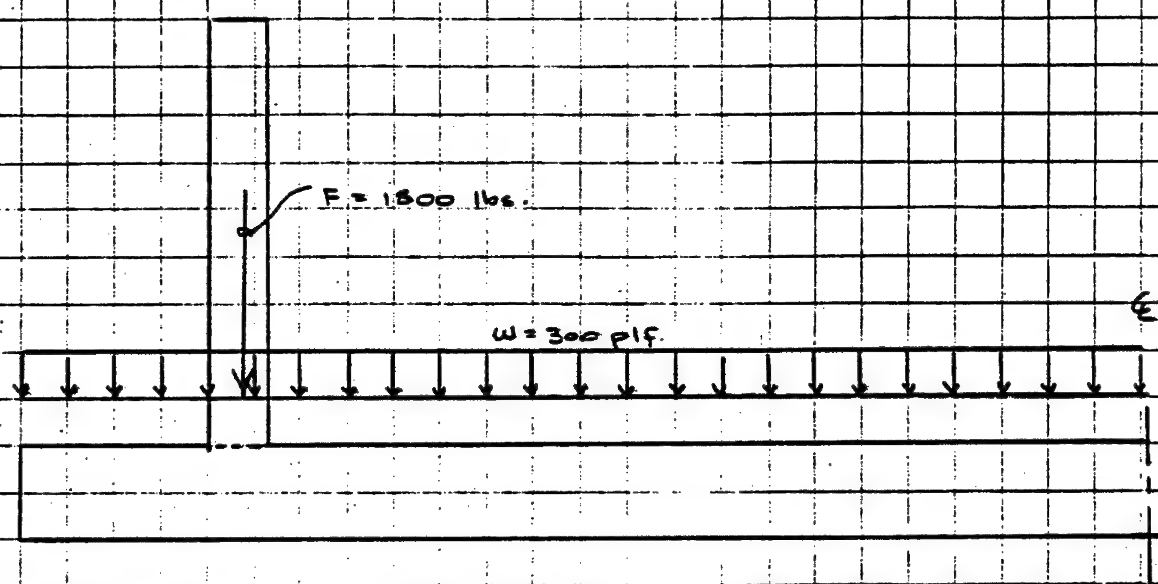
EL:

Same as WL except:

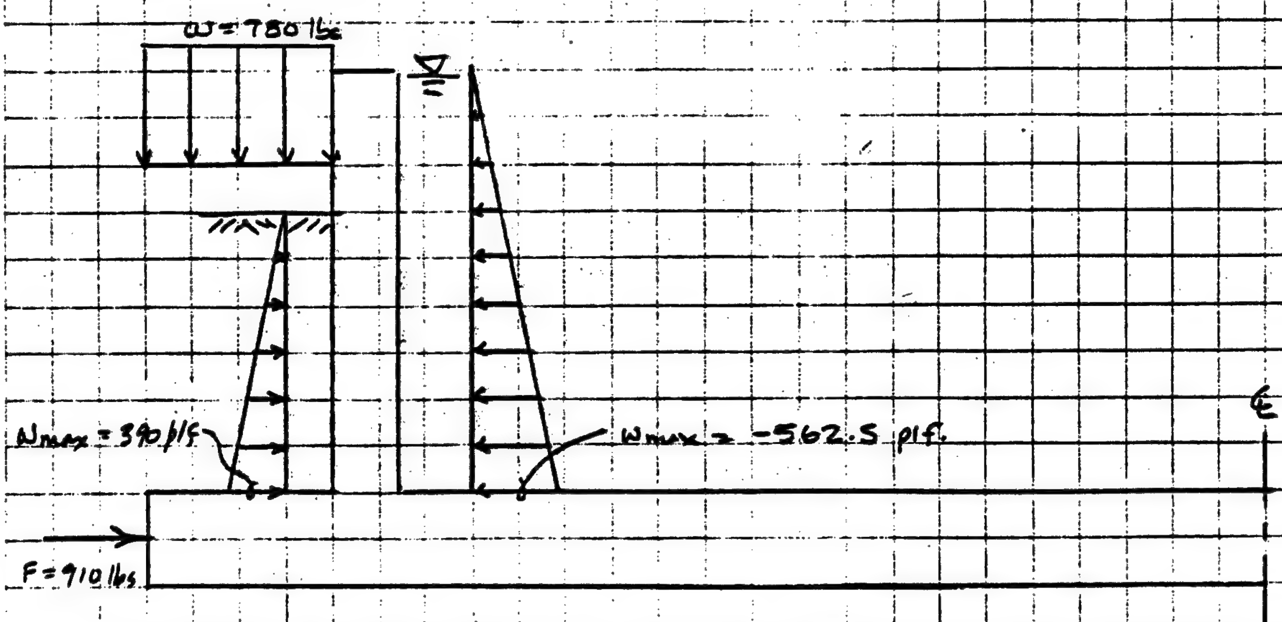
Uplift Force applied to Members 14 - 27:

F = 7' head x 62.5 pcf = -437.5 lb/ft.

BONESTROO, ROSENE, ANDERLIK & ASSOC., INC. CONSULTING ENGINEERS St. Paul, Minnesota	Client	Page 17
	Project	Proj. No.
Calculations For	Prepared By	Date
	Reviewed By	Date

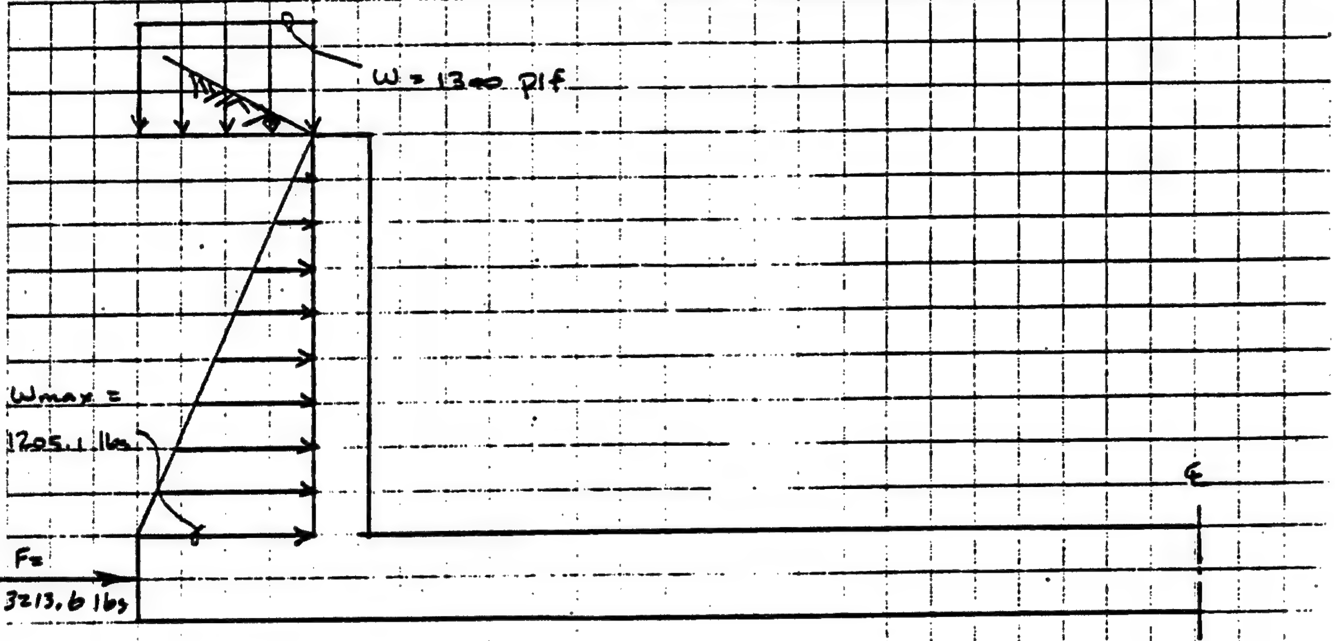


Dead Load.

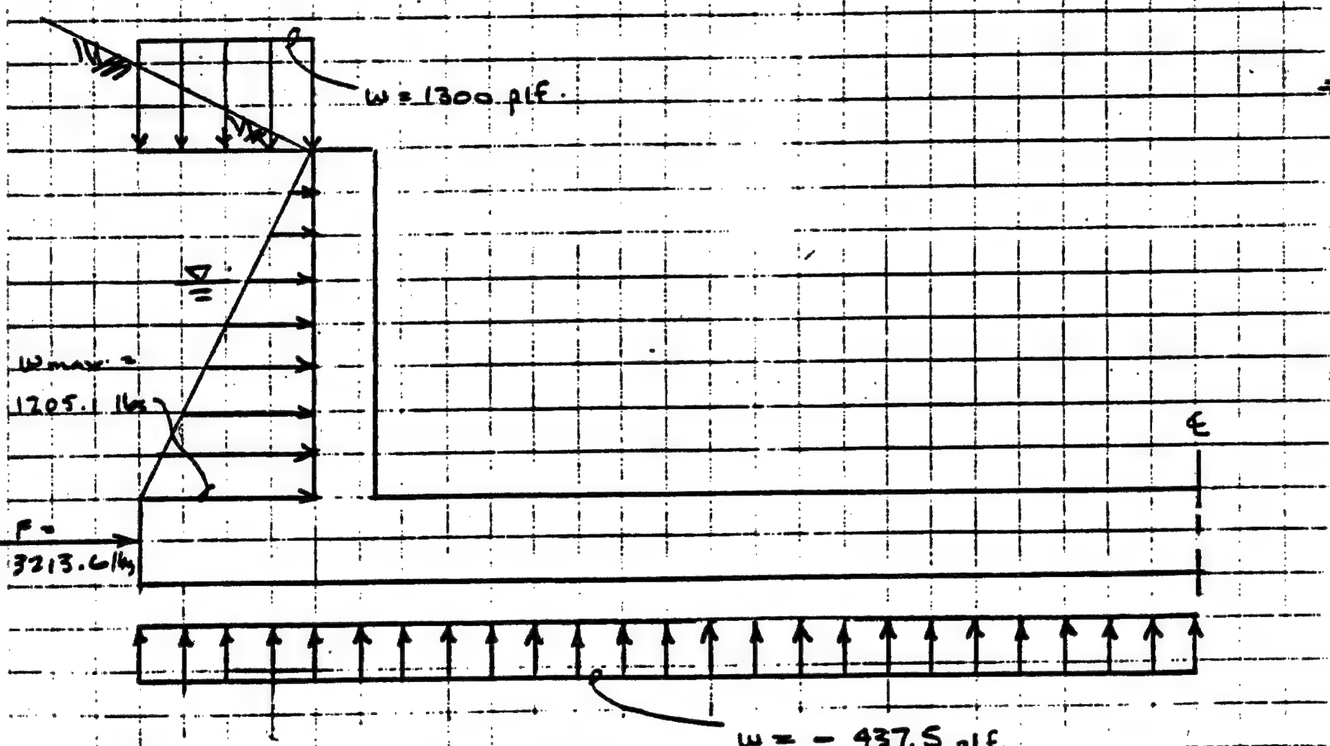


Live Load.

BONESTROO, ROSENE, ANDERLIK & ASSOC., INC. CONSULTING ENGINEERS St. Paul, Minnesota	Client	Page 18
	Project	Proj. No.
Calculations For:	Prepared By	Date
	Reviewed By	Date



Wind Load



Earth Load

BONESTROO, ROSENE, ANDERLIK & ASSOC., INC. **CONSULTING ENGINEERS** St. Paul, Minnesota	Client Project	Page 5. Proj. No. 11507
Calculations For	Prepared By Reviewed By	Date 2/14/84 Date

Develope Model:

Supercritical Flow Channel

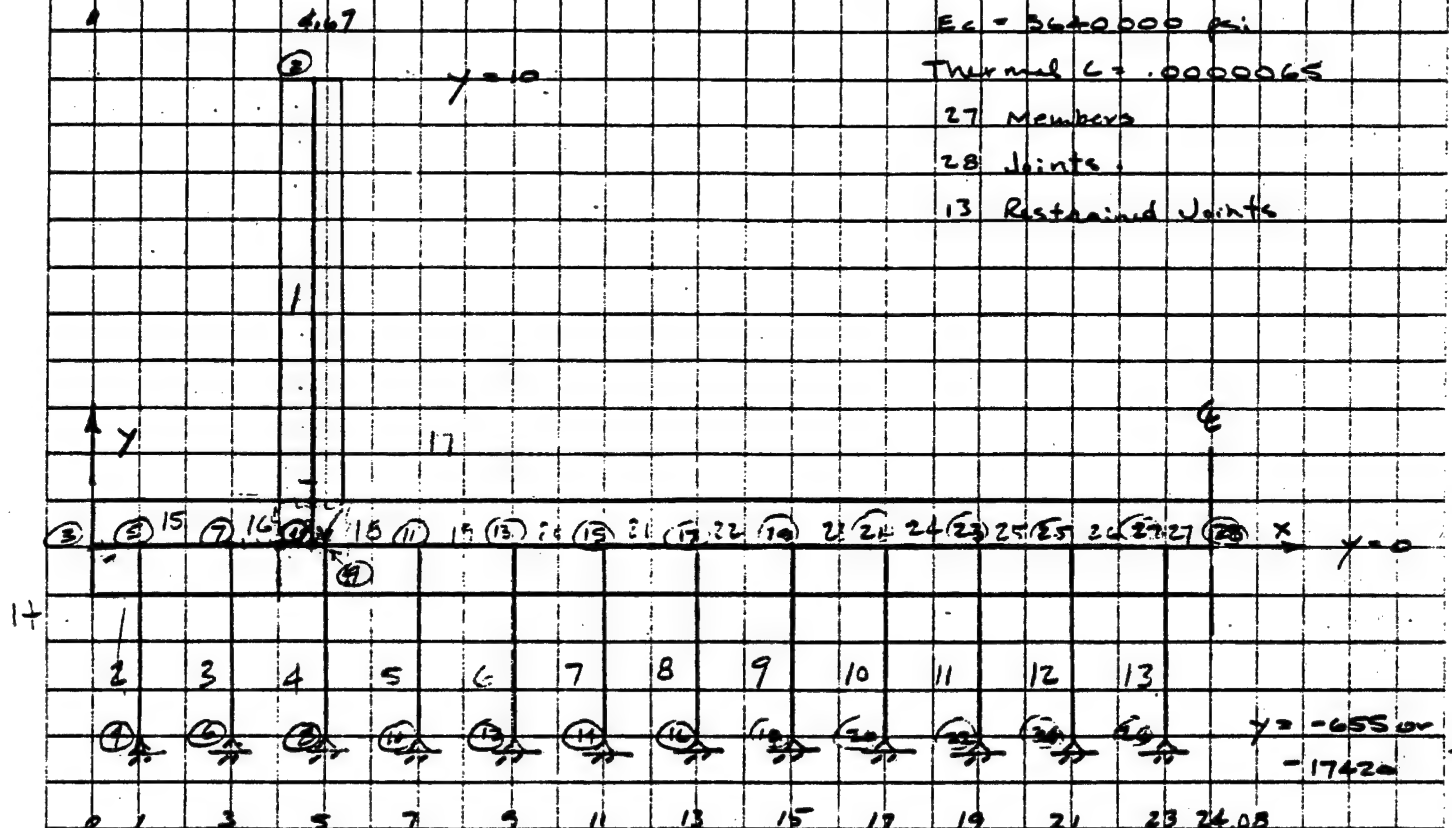
Ec = 3640000 psi

Thermal C = .0000065

27 Members

28 Joints

13 Restrained Joints



Member	B	H	Type
1	12"	16"	1
2-27	12"	24"	2

Restricted Joints

4, 6, 8 ... 26 Fix X, Y, M

28 Fix X, M; Free Y

Pinned Member

2-13 Free Both Ends.

BONESTROO, ROSENE, ANDERLIK & ASSOC., INC.
CONSULTING ENGINEERS
St. Paul, Minnesota

Client
Project
Page 19
Proj. No.

Calculations For
Prepared By
Reviewed By
Date
Date

Loading Data:

DL: 1 Loaded Joint, 14 Loaded Members

Joint 1: 1800 lbs Vert

Members:

14	300	300	0	1
16	↓	↓	↓	1.67
17				0.33
27				1.08
15, 18-26				2

LL: 1 Loaded Joint, 4 Loaded Members

Joint 3: 910 lbs Hor.

Members:

1	-562.5	0	1	10
	390	0	1	7
14	780	780	0	1
15	↓	↓	↓	2
16				1

WL: 1 Loaded Joint, 4 Loaded Members.

Joint 3: 3213.6 lbs Hor.

Members:

1	1205.1	0	1	10
14	1300	1300	0	1
15	↓	↓	↓	2
16				1

BONESTROO, ROSENE, ANDERLIK & ASSOC., INC.
CONSULTING ENGINEERS
St. Paul, Minnesota

Client
Project
Page 20
Proj. No.

Calculations For
Prepared By
Reviewed By
Date
Date

EL: 1 Loaded Joint, 15 Loaded Members

Joint 3: 3213.6 lbs Hor.

Members:

1	1205.1	0	1	10
14	1300	1300	0	1
	-437.5	-437.5	0	1
15	1300	1300	0	2
	-437.5	-437.5	0	2
16	1300	1300	0	1
	-437.5	-437.5	0	1.67
17	↓	↓	↓	0.33
27	↓	↓	↓	1.08
18-26	↓	↓	↓	2

BONESTROO, ROSENE, ANDERLIK & ASSOC., INC. CONSULTING ENGINEERS St. Paul, Minnesota	Client U.S. Corps of Engineers	Page 21
	Project West Creek, Chaska, MN	Proj. No. 11507
Calculations For Supercritical Channel Design	Prepared By Keith Bachman	Date 2/18/84
	Reviewed By	Date

Computer Results Summary

COMPUTER OUTPUT ATTACHED [illegible]

[illegible]

Unfactored Data		No Members Cut			7 Members Cut	
Joint	Data	DL	LL	WL	DL	EL
2	X-Disp.	-.0038	-.0432	.0536	.0801	-.0451
3	Y-Disp.	.0154	.0237	.0139	-.0128	.0350
28	Y-Disp.	.0086	-.0023	-.0004	.1494	-.1833
4	Vert. F	1009	1404	897	-336	1672
6		971	1055	839	706	345
8		925	712	817	1767	-978
10		865	422	757	2865	-2404
12		801	205	640	4021	-3968
14		741	53	499	0	0
16		690	-45	359		
18		649	-103	234		
20		618	-134	130		
22		596	-147	52		
24		583	-151	0		
26		576	-152	-26		

Factored Data		No Members Cut	7 Members Cut
Member	Data	Combo 1 & 2	Combo 3
1	Mmax	41.2 K-ft	41.2 K-ft
1	Fmax	—	—
1	Vmax	10.3 K	10.3 K
14-27	Mmax	26.8 K-ft	31.6 K-ft
F @ Mmax Point		16.4 K	16.4 K
14-27	Vmax	8.4 K	6.4 K

BONESTROO, ROSENE, ANDERLIK & ASSOC., INC. CONSULTING ENGINEERS St. Paul, Minnesota	Client	Page 22
	Project	Proj. No.
Calculations For	Prepared By	Date
	Reviewed By	Date

Maximum Soil Bearing Pressure = (1009 + 1404) / 2 sq. ft = 1206 psf.
← Max Soil Column Load Combo.

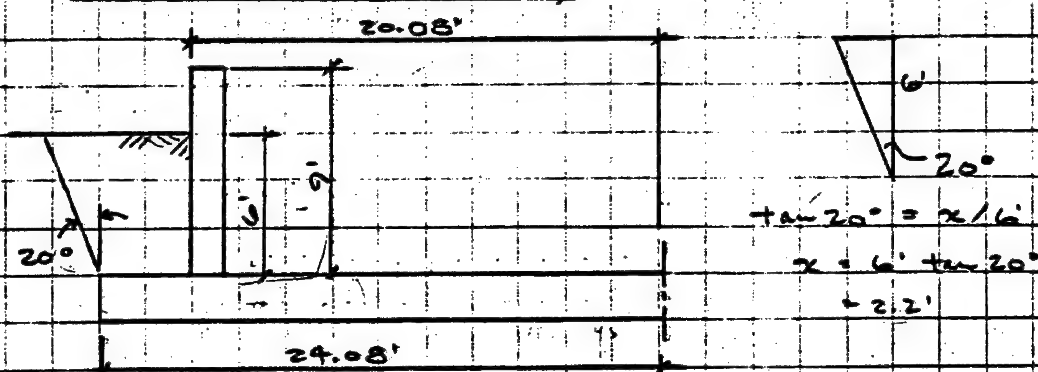
Check Ko Assumption:

Case	Joint 2 X-Displ.
DL + LL	−.0470 in. < 2.16 in.
DL + WL	.0498 in. < .54 in.
DL + EL	.0350 in. < .54 in.

$\Delta_A = .005H = .005(9')(12''/') = 0.54$ in.
$\Delta_P = .02H = .02(9')(12''/') = 2.16$ in.

∴ At Rest Assumption is OK.

Recheck Uplift Stability:



$\tan 20° = x/6'$
$x = 6' \tan 20°$
$= 2.2'$

Conc. wt: [2 × 9' × 1.33' + 2 × 24.08' × 2'] .15 kcf = 18.04 k
Soil wt: [2 × 6' × (4' + 1.1')](.13 kcf − .0625 kcf) = 4.13 k
Total: 22.17 k

Uplift: [2 × 5' × 20.08' + 2 × 2' × 24.08'] .0625 kcf = 18.57 k

S.F. = (18.04 k + 4.13 k) / 18.57 k = 1.19 > 1.15 — OK.

BONESTROO, ROSENE, ANDERLIK & ASSOC., INC. CONSULTING ENGINEERS St. Paul, Minnesota	Client	Page 23
	Project	Proj. No.
Calculations For	Prepared By	Date
	Reviewed By	Date

Check Sliding Stability:

Assumed Worst Case:

1 Side Backfilled to Top w/ 2:1 Sloped Surcharge

Other Side Backfilled to 6' above Channel Invert – Level.

Sliding is Most Likely w/ DL + EL.

Assume No Soil Friction @ Cut Members.

4 Members Cut = 8.08' / ½ section.

= 16.16' total.

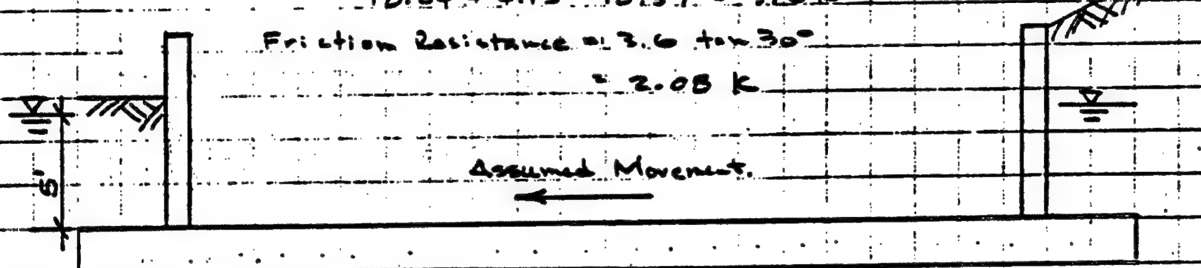
Effective Soil Friction Length = 48.16' – 16.16' = 32'

Net Weight = Conc Wt + Soil Wt – Uplift

= 18.04 + 4.13 – 18.57 = 3.6 k

Friction Resistance = 3.6 tan 30°

= 2.08 k



Assume that after small movement to left, mobilized lateral earth pressures will govern stability check.

KA 2:1 = 0.53

Kp Level = 3.00

Driving Stresses: 4' × 130 × .53 = 276 psf

276 psf + 7' × 67.5 × .53 + 7' × 62.5 = 963 psf.

Resisting Stresses: 1' × 130 × 3.0 = 390 psf

390 psf + 7' × 67.5 × 3.0 + 7' × 62.5 = 2245 psf.

Driving Force: 276 × 4'/2 + 276 × 7' + (963 – 276) × 7'/2 = 4.89 k.

Resist. Force: 390 × 1'/2 + 390 × 7' + (2245 – 390) × 7'/2 = 9.42 k.

Friction Resistance: 2.08 k.

Sliding S.F. = (9.42 + 2.08) / 4.89 = 2.35 > 1.5 — OK.

BONESTROO, ROSENE, ANDERLIK & ASSOC., INC.
CONSULTING ENGINEERS
St. Paul, Minnesota

Client
Project
Page 24
Proj. No.
Calculations For
Prepared By
Date
Reviewed By
Date

Wall Steel (per T.R. SL-30-4, Report 2):

Max Factored Compression Load
@ Base of Wall = 1.5 (1800 lbs) = 2.7 k

Max Factored Moment @ Base of Wall = 41.2 k-ft = 495 k-in,

d = 12.5"

ρ_{min} = .0042 $A_{s\,min}$ = .0042 × 12.5 × 12 = 0.63 in^2

ρ_{max} = .75 ρ_b = .0097 $A_{s\,max}$ = .0097 × 12.5 × 12 = 1.45 in^2

h/d = 16/12.5 = 1.28 ≈ 1.3

$\phi = .9 - 2 P_u / f'_c b h = .9 - 2(2.7)/(4 \times 12 \times 16) = 0.89$

$M_n = M_u/\phi = 41.2/.89 = 45.8$ k-ft
$P_n = P_u/\phi = 2.7/.89 = 3.0$ k
$M_n/bd^2 = (45.8 \text{ k-ft} \times 12)/(12 \times 12.5^2) = 0.29$
$P_n/bd = 3.0 \text{ k}/(12 \times 12.5) = 0.02$
Figure 20 → $\rho_{req'd}$ = .0065 ∴ $A_{s\,req'd}$ = 0.97 in^2

∴ Select #9 @ 12 max. A_s = 1.00 in^2. ρ = .0067

BONESTROO, ROSENE, ANDERLIK & ASSOC., INC. CONSULTING ENGINEERS St. Paul, Minnesota	Client	Page 25
	Project	Proj. No.
Calculations For	Prepared By	Date
	Reviewed By	Date

Check Wall Steel (per ETL 1110-2-265): $A_s = \rho bd = 1.0 \text{ in}^2$, $\rho = .0067$

$\phi P_n = .7\phi\,[0.85 f'_c (A_g - \rho bd) + f_y \rho bd]$

$= .7 \times .89 \times [.85 \times 4 \times (12 \times 12.5 - 1) + 48 \times 1]$

$= 349.4\ K > 2.7\ K$

$\epsilon_m = 0.0015 \qquad \beta_m = .55$

$k_m = \beta_m E_s \epsilon_m / (E_s \epsilon_m + f_y)$

$= .55 \times 29000 \times .0015 / (29000 \times .0015 + 48) = 0.261$

$e'_m/d = (2k_m - k_m^2) / (2k_m - \rho f_y/(.425 f'_c))$

$= (2 \times .261 - .261^2) / (2 \times .261 - .0067 \times 48 / (.425 \times 4))$

$= 1.36$

$(e'_m/d)_{actual} = (M_u/P_u + d - h/2)/d$

$= (495/2.7 + 12.5 - 8)/12.5 = 15.0 > 1.36$

$\therefore$ Tension Controls.

$k_u = \sqrt{(e'/d - 1)^2 + (\rho f_y/(.425 f'_c))\, e'/d} - (e'/d - 1)$

$= \sqrt{(15-1)^2 + (.0067 \times 48/(.425 \times 4))\, 15} - (15-1)$

$= \sqrt{14^2 + .189 \times 15} - 14 = .101$

$\phi P_n = \phi\,[.85 f'_c k_u - \rho f_y]\, bd$

$= .89\,[.85 \times 4 \times .101 - .0067 \times 48]\, 12 \times 12.5 = 2.94\ K \approx 3.0\ K$ — OK.

$\phi M_n = \phi\,[.85 f'_c k_u - \rho f_y][e'/d - (1 - h/2d)]\, bd^2$

$= .89\,[.85 \times 4 \times .101 - .0067 \times 48][15 - (1 - 16/25)]\, 12 \times 12.5^2$

$= .89 \times .0218 \times 14.64 \times 12 \times 12.5^2$

$= 538\ \text{k-in} > 495\ \text{k-in}$ — OK.

Note: Since ETL 1110-2-265 & T.R. SL-80-4, Report 2 Yeild Similar Results and Since this is Not Exact Final Reinforcement Calculations, All Future Steel Calculations will be based upon Tables in T.R. SL-80-4, Report 2.

Slab Steel:

Max Factored Moment = 31.6 k-ft = 380 k-in

Axial Factored Force @ Point of Max Moment = 16.4 k.

$d = 20.5"$

$\rho_{min} = .0042$ $A_{s\,min} = 1.03\ in^2$

$\rho_{max} = .0097$ $A_{s\,max} = 2.39\ in^2$

$h/d = 24/20.5 = 1.17 \approx 1.2$

$\phi = .9 - 2P_u/f'_c bh = .9 - 2(16.4)/(4 \times 12 \times 24) = 0.87$

$M_n/bd^2 = M_u/\phi bd^2 = 380/(.87 \times 12 \times 20.5^2) = 0.087$

$P_n/bd = P_u/\phi bd = 16.4/(.87 \times 12 \times 20.5) = 0.077$

Figure 19 ⟶ $\rho_{req'd} = .0015$

ρ_{min} (per ACI 10.5.2) $= .0015 \times 4/3 = .0020$

∴ Select #7 @ 12 max. $A_s = 0.60\ in^2$ $\rho = .0024$

Check Shear: $V_u = \phi V_n = \phi \times 2 \times \sqrt{f'_c} \times b \times d$

$\phi = 0.85$

$f'_c = 4000$ psi

$b = 12"$ ∴ $V_u = 1290.2\ d$

Section	d	Vu	Vu req'd	
Wall	12.5"	16.1 k	10.3 k	ok
Slab	20.5"	26.4 k	8.4 k	ok

Shrinkage & Temperature Reinforcement:

$A_{s\,slab} = .002 \times 12 \times 20.5 / 2$ faces $= 0.25\ in^2$

Use #5 @ 12

$A_{s\,wall} = .004 \times 12 \times 12.5 / 2$ faces $= 0.30\ in^2$

Use #5 @ 12

===

*** PLANE FRAMED STRUCTURES PROGRAM 'PFRAME' ***

===

****
! BONESTROO; ROSENE; ANDERLIK; & ASSOCIATES; INC. !
****

NAME OF PROJECT

! #11507 CHASKA WEST CREEK - SUPERCRITICAL FLOW CHANNEL !

DATE

! 2/18/84 !

PARAMETER	ENGLISH SYSTEM
Modulus of Elasticity (E)	lb/in2
Coordinates	ft
Dimensions (B,H)	in
Inertia (I)	ft4
Area (A)	ft2
Forces and Shears	lb
Moments	lb-ft
Distributed Loads	lb/ft
Uniform Temperature Change	^F
Linear Temperature Gradient per Height of Element	^F/ft
Coefficient of Thermal Expansion	1/^F
Displacements	in
Rotations	Radians

lb = Pounds　　in = inches

^F = Degrees Fahrenheit　　ft = Feet

```
**********************************************************
!       BONESTROO; ROSENE; ANDERLIK; & ASSOCIATES; INC.      !
**********************************************************
```

#11507 CHASKA WEST CREEK - SUPERCRITICAL FLOW CHANNEL
2/18/84 [GEOMETRY]

# MEMBERS	# JOINTS	# RESTRIC. JOINTS	E [lb/in2]	THERMAL C.
27	28	13	3640000	.0000065

JOINT COORDINATES

JOINT #	X [ft]	Y [ft]
1	4.67	0.00
2	4.67	10.00
3	0.00	0.00
4	1.00	%-1310.00
5	1.00	0.00
6	3.00	%-1310.00
7	3.00	0.00
8	5.00	%-1310.00
9	5.00	0.00
10	7.00	%-1310.00
11	7.00	0.00
12	9.00	%-1310.00
13	9.00	0.00
14	11.00	%-1310.00
15	11.00	0.00
16	13.00	%-1310.00
17	13.00	0.00
18	15.00	%-1310.00
19	15.00	0.00
20	17.00	%-1310.00
21	17.00	0.00
22	19.00	%-1310.00
23	19.00	0.00
24	21.00	%-1310.00
25	21.00	0.00
26	23.00	%-1310.00
27	23.00	0.00
28	24.08	0.00

TYPES OF SECTIONS

TYPE #	SECTION (BxH)
1	12 x 16
2	12 x 24
3	0 x 0

MEMBER INFORMATION, ORIENTATION AND PROPERTIES

MEMB #	End J	End K	TYPE	Inert [ft4]	Area [ft2]	Length	SIN	COS
1	1	2	1	0.19753090	1.33333302	10.00	1.000	0.000
2	4	5	2	0.66666669	2.00000000	%1310.00	1.000	0.000
3	6	7	2	0.66666669	2.00000000	%1310.00	1.000	0.000

```
************************************************************
!        BONESTROO; ROSENE; ANDERLIK; & ASSOCIATES; INC.      !
************************************************************
```

#11507 CHASKA WEST CREEK – SUPERCRITICAL FLOW CHANNEL
2/18/84 [GEOMETRY]

MEMBER INFORMATION, ORIENTATION AND PROPERTIES

MEMB #	End J	End K	TYPE	Inert [ft4]	Area [ft2]	Length	SIN	COS
4	8	9	2	0.66666669	2.00000000	%1310.00	1.000	0.000
5	10	11	2	0.66666669	2.00000000	%1310.00	1.000	0.000
6	12	13	2	0.66666669	2.00000000	%1310.00	1.000	0.000
7	14	15	3	0.00000000	0.00000000	%1310.00	1.000	0.000
8	16	17	3	0.00000000	0.00000000	%1310.00	1.000	0.000
9	18	19	3	0.00000000	0.00000000	%1310.00	1.000	0.000
10	20	21	3	0.00000000	0.00000000	%1310.00	1.000	0.000
11	22	23	3	0.00000000	0.00000000	%1310.00	1.000	0.000
12	24	25	3	0.00000000	0.00000000	%1310.00	1.000	0.000
13	26	27	3	0.00000000	0.00000000	%1310.00	1.000	0.000
14	3	5	2	0.66666669	2.00000000	1.00	0.000	1.000
15	5	7	2	0.66666669	2.00000000	2.00	0.000	1.000
16	7	1	2	0.66666669	2.00000000	1.67	0.000	1.000
17	1	9	2	0.66666669	2.00000000	0.33	0.000	1.000
18	9	11	2	0.66666669	2.00000000	2.00	0.000	1.000
19	11	13	2	0.66666669	2.00000000	2.00	0.000	1.000
20	13	15	2	0.66666669	2.00000000	2.00	0.000	1.000
21	15	17	2	0.66666669	2.00000000	2.00	0.000	1.000
22	17	19	2	0.66666669	2.00000000	2.00	0.000	1.000
23	19	21	2	0.66666669	2.00000000	2.00	0.000	1.000
24	21	23	2	0.66666669	2.00000000	2.00	0.000	1.000
25	23	25	2	0.66666669	2.00000000	2.00	0.000	1.000
26	25	27	2	0.66666669	2.00000000	2.00	0.000	1.000
27	27	28	2	0.66666669	2.00000000	1.08	0.000	1.000

CUT

RESTRICTED JOINTS

JOINT #	X Disp.	Y Disp.	Z Rot.
4	1	1	1
6	1	1	1
8	1	1	1
10	1	1	1
12	1	1	1
14	1	1	1
16	1	1	1
18	1	1	1
20	1	1	1
22	1	1	1
24	1	1	1
26	1	1	1
28	1	0	1

PINNED MEMBERS

MEMBER #	ENDS J/K	END JJ	END JK
2	4 / 5	1	1

****
! BONESTROO; ROSENE; ANDERLIK; & ASSOCIATES; INC. !
****

#11507 CHASKA WEST CREEK - SUPERCRITICAL FLOW CHANNEL
2/18/84 [GEOMETRY]

PINNED MEMBERS

MEMBER #	ENDS J/K	END JJ	END JK
3	6 / 7	1	1
4	8 / 9	1	1
5	10 / 11	1	1
6	12 / 13	1	1
7	14 / 15	1	1
8	16 / 17	1	1
9	18 / 19	1	1
10	20 / 21	1	1
11	22 / 23	1	1
12	24 / 25	1	1
13	26 / 27	1	1

```
***************************************************************
!       BONESTROO; ROSENE; ANDERLIK; & ASSOCIATES; INC.       !
***************************************************************
```

#11507 CHASKA WEST CREEK - SUPERCRITICAL FLOW CHANNEL
2/18/84 CASE --> [DEAD LOAD]

JOINT LOADS

JOINT #	Horiz F.	Vert F.	Moment
1 ✓	0	1800 ✓	0

```
*****************************************************************
!        BONESTROO; ROSENE; ANDERLIK; & ASSOCIATES; INC.        !
*****************************************************************
```

#11507 CHASKA WEST CREEK - SUPERCRITICAL FLOW CHANNEL
2/18/84 CASE --> [DEAD LOAD]

GROUP # : 1 VERTICAL LOADS

14

\# Dist. Loads : 1 — # Point Loads : 0

ORDER #	Init. W	Final W	Init. X	Final X	Point X	P
1	300	300	0	1		

GROUP # : 2 VERTICAL LOADS

16

\# Dist. Loads : 1 — # Point Loads : 0

ORDER #	Init. W	Final W	Init. X	Final X	Point X	P
1	300	300	0	1.67		

GROUP # : 3 VERTICAL LOADS

17

\# Dist. Loads : 1 — # Point Loads : 0

ORDER #	Init. W	Final W	Init. X	Final X	Point X	P
1	300	300	0	.33		

GROUP # : 4 VERTICAL LOADS

27

\# Dist. Loads : 1 — # Point Loads : 0

ORDER #	Init. W	Final W	Init. X	Final X	Point X	P
1	300	300	0	1.08		

GROUP # : 5 VERTICAL LOADS

15 18 19 20 21 22 23 24 25 26

\# Dist. Loads : 1 — # Point Loads : 0

ORDER #	Init. W	Final W	Init. X	Final X	Point X	P
1	300	300	0	2		

****
! BONESTROO; ROSENE; ANDERLIK; & ASSOCIATES; INC. !
****

#11507 CHASKA WEST CREEK - SUPERCRITICAL FLOW CHANNEL
2/18/84 CASE --> [DEAD LOAD]

JOINT DISPLACEMENTS

JOINT #	X Disp.	Y Disp.	Z Rot.
1	-0.000000	0.023841	-0.000668
2	0.080132	0.023841	-0.000668
3	-0.000000	-0.012840	-0.000650
4	0.000000	0.000000	0.000000
5	-0.000000	-0.005045	-0.000650
6	0.000000	0.000000	0.000000
7	-0.000000	0.010594	-0.000655
8	0.000000	0.000000	0.000000
9	-0.000000	0.026492	-0.000671
10	0.000000	0.000000	0.000000
11	-0.000000	0.042958	-0.000704
12	0.000000	0.000000	0.000000
13	-0.000000	0.060295	-0.000740
14	0.000000	0.000000	0.000000
15	-0.000000	0.078231	-0.000747
16	0.000000	0.000000	0.000000
17	-0.000000	0.095788	-0.000709
18	0.000000	0.000000	0.000000
19	-0.000000	0.111973	-0.000634
20	0.000000	0.000000	0.000000
21	-0.000000	0.125953	-0.000527
22	0.000000	0.000000	0.000000
23	-0.000000	0.137064	-0.000396
24	0.000000	0.000000	0.000000
25	-0.000000	0.144805	-0.000247
26	0.000000	0.000000	0.000000
27	-0.000000	0.148839	-0.000088
28	0.000000	0.149409	0.000000

MEMBER END-ACTIONS

MEMBER	END	Axial F.	Shear F.	Moment
1	1	0	0	0
	2	0	0	0
2	4	336	0	0
	5	336	0	0
3	6	-706	0	0
	7	-706	0	0
4	8	-1767	0	0
	9	-1767	0	0
5	10	-2865	0	0
	11	-2865	0	0
6	12	-4021	0	0
	13	-4021	0	0
7	14	-0	0	0
	15	-0	0	0
8	16	-0	0	0
	17	-0	0	0

****
! BONESTROO; ROSENE; ANDERLIK; & ASSOCIATES; INC. !
****

#11507 CHASKA WEST CREEK - SUPERCRITICAL FLOW CHANNEL
2/18/84 CASE --> [DEAD LOAD]

MEMBER END-ACTIONS

MEMBER	END	Axial F.	Shear F.	Moment
9	18	-0	0	0
	19	-0	0	0
10	20	-0	0	0
	21	-0	0	0
11	22	-0	0	0
	23	-0	0	0
12	24	-0	0	0
	25	-0	0	0
13	26	-0	0	0
	27	-0	0	0
14	3	0	2	-1
	5	0	-298	-149
15	5	0	-636	-150
	7	0	-1236	-2023
16	7	0	-530	-2023
	1	0	-1031	-3326
17	1	0	-2855	-3322
	9	0	-2954	-4281
18	9	0	-1162	-4274
	11	0	-1762	-7198
19	11	0	1102	-7199
	13	0	502	-5595
20	13	0	4523	-5595
	15	0	3923	2852
21	15	0	3923	2852
	17	0	3323	10098
22	17	0	3323	10098
	19	0	2723	16144
23	19	0	2726	16141
	21	0	2126	20993
24	21	0	2121	20993
	23	0	1521	24634
25	23	0	1525	24635
	25	0	925	27085
26	25	0	923	27084
	27	0	323	28330
27	27	0	313	28335
	28	0	-11	28498

SUPPORT ACTIONS

JOINT #	Horiz F.	Vert F.	Moment
4	0	-336	0
6	0	706	0
8	0	1767	0
10	0	2865	0
12	0	4021	0
14	0	0	0

```
*****************************************************************
!       BONESTROO; ROSENE; ANDERLIK; & ASSOCIATES; INC.          !
*****************************************************************
```

#11507 CHASKA WEST CREEK - SUPERCRITICAL FLOW CHANNEL
2/18/84 CASE --> [DEAD LOAD]

SUPPORT ACTIONS

JOINT #	Horiz F.	Vert F.	Moment
16	0	0	0
18	0	0	0
20	0	0	0
22	0	0	0
24	0	0	0
26	0	0	0
28	-0	0	-28498

```
*************************************************************
!        BONESTROO; ROSENE; ANDERLIK; & ASSOCIATES; INC.       !
*************************************************************
```

#11507 CHASKA WEST CREEK - SUPERCRITICAL FLOW CHANNEL
2/18/84 CASE --> [EARTH LOAD]

JOINT LOADS

JOINT #	Horiz F.	Vert F.	Moment
3	3214	0	0

```
*************************************************************
!        BONESTROO; ROSENE; ANDERLIK; & ASSOCIATES; INC.     !
*************************************************************
```

#11507 CHASKA WEST CREEK - SUPERCRITICAL FLOW CHANNEL
CASE --> [EARTH LOAD]
2/18/84

GROUP # : 1 — HORIZONTAL LOADS

1

Dist. Loads : 1 — # Point Loads : 0

ORDER #	Init. W	Final W	Init. Y	Final Y	Point Y	P
1	1205.1	0	1	10		

GROUP # : 2 — VERTICAL LOADS

14

Dist. Loads : 2 — # Point Loads : 0

ORDER #	Init. W	Final W	Init. X	Final X	Point X	P
1	1300	1300	0	1		
2	-437.5	-437.5	0	1		

GROUP # : 3 — VERTICAL LOADS

15

Dist. Loads : 2 — # Point Loads : 0

ORDER #	Init. W	Final W	Init. X	Final X	Point X	P
1	1300	1300	0	2		
2	-437.5	-437.5	0	2		

GROUP # : 4 — VERTICAL LOADS

16

Dist. Loads : 2 — # Point Loads : 0

ORDER #	Init. W	Final W	Init. X	Final X	Point X	P
1	1300	1300	0	1		
2	-437.5	-437.5	0	1.67		

```
**************************************************************
!       BONESTROO; ROSENE; ANDERLIK; & ASSOCIATES; INC.      !
**************************************************************
```

#11507 CHASKA WEST CREEK - SUPERCRITICAL FLOW CHANNEL
2/18/84 CASE --> [EARTH LOAD]

GROUP # : 5 VERTICAL LOADS

17

\# Dist. Loads : 1 # Point Loads : 0

ORDER #	Init. W	Final W	Init. X	Final X	Point X	P
1	-437.5	-437.5	0	.33		

GROUP # : 6 VERTICAL LOADS

27

\# Dist. Loads : 1 # Point Loads : 0

ORDER #	Init. W	Final W	Init. X	Final X	Point X	P
1	-437.5	-437.5	0	1.08		

GROUP # : 7 VERTICAL LOADS

18 19 20 21 22 23 24 25 26

\# Dist. Loads : 1 # Point Loads : 0

ORDER #	Init. W	Final W	Init. X	Final X	Point X	P
1	-437.5	-437.5	0	2		

****

! BONESTROO; ROSENE; ANDERLIK; & ASSOCIATES; INC. !

****

#11507 CHASKA WEST CREEK - SUPERCRITICAL FLOW CHANNEL
2/18/84 CASE --> [EARTH LOAD]

JOINT DISPLACEMENTS

JOINT #	X Disp.	Y Disp.	Z Rot.
1	0.001719	-0.011379	0.000822
2	-0.045195	-0.011379	0.000285
3	0.002091	0.035023	0.000830
4	0.000000	0.000000	0.000000
5	0.002054	0.025065	0.000829
6	0.000000	0.000000	0.000000
7	0.001980	0.005171	0.000828
8	0.000000	0.000000	0.000000
9	0.001886	-0.014669	0.000840
10	0.000000	0.000000	0.000000
11	0.001689	-0.036044	0.000939
12	0.000000	0.000000	0.000000
13	0.001491	-0.059508	0.001011
14	0.000000	0.000000	0.000000
15	0.001293	-0.084146	0.001031
16	0.000000	0.000000	0.000000
17	0.001095	-0.108449	0.000985
18	0.000000	0.000000	0.000000
19	0.000898	-0.130965	0.000883
20	0.000000	0.000000	0.000000
21	0.000700	-0.150483	0.000736
22	0.000000	0.000000	0.000000
23	0.000502	-0.166032	0.000554
24	0.000000	0.000000	0.000000
25	0.000304	-0.176880	0.000346
26	0.000000	0.000000	0.000000
27	0.000107	-0.182539	0.000123
28	0.000000	-0.183340	0.000000

MEMBER END-ACTIONS

MEMBER	END	Axial F.	Shear F.	Moment
1	1	0	5423	-21692
	2	0	0	0
2	4	-1672	0	0
	5	-1672	0	0
3	6	-345	0	0
	7	-345	0	0
4	8	978	0	0
	9	978	0	0
5	10	2404	0	0
	11	2404	0	0
6	12	3968	0	0
	13	3968	0	0
7	14	0	0	0
	15	0	0	0
8	16	0	0	0
	17	0	0	0

****
! BONESTROO; ROSENE; ANDERLIK; & ASSOCIATES; INC. !
****

#11507 CHASKA WEST CREEK - SUPERCRITICAL FLOW CHANNEL
2/18/84 CASE --> [EARTH LOAD]

MEMBER END-ACTIONS

MEMBER	END	Axial F.	Shear F.	Moment
9	18	0	0	0
	19	0	0	0
10	20	0	0	0
	21	0	0	0
11	22	0	0	0
	23	0	0	0
12	24	0	0	0
	25	0	0	0
13	26	0	0	0
	27	0	0	0
14	3	-3214	3	-1
	5	-3214	-860	-430
15	5	-3214	809	-431
	7	-3214	-916	-538
16	7	-3214	-571	-538
	1	-3214	-1141	-2403
17	1	-8636	-1118	19284
	9	-8636	-974	18939
18	9	-8637	-1974	18934
	11	-8637	-1099	15860
19	11	-8637	-3503	15861
	13	-8637	-2628	9729
20	13	-8637	-6597	9730
	15	-8637	-5722	-2588
21	15	-8637	-5721	-2588
	17	-8637	-4846	-13156
22	17	-8637	-4847	-13155
	19	-8637	-3972	-21974
23	19	-8637	-3969	-21975
	21	-8637	-3094	-29039
24	21	-8637	-3096	-29042
	23	-8637	-2221	-34359
25	23	-8637	-2222	-34359
	25	-8637	-1347	-37928
26	25	-8637	-1346	-37929
	27	-8637	-471	-39746
27	27	-8637	-482	-39740
	28	-8637	-9	-40005

SUPPORT ACTIONS

JOINT #	Horiz F.	Vert F.	Moment
4	0	1672	0
6	0	345	0
8	0	-978	0
10	0	-2404	0
12	0	-3968	0
14	0	-0	0

```
*************************************************************
|       BONESTROO; ROSENE; ANDERLIK; & ASSOCIATES; INC.      |
*************************************************************
```

#11507 CHASKA WEST CREEK - SUPERCRITICAL FLOW CHANNEL
2/18/84 CASE --> [EARTH LOAD]

SUPPORT ACTIONS

JOINT #	Horiz F.	Vert F.	Moment
16	0	-0	0
18	0	-0	0
20	0	-0	0
22	0	-0	0
24	0	-0	0
26	0	-0	0
28	8637	0	40005

```
*****************************************************************
!       BONESTROO; ROSENE; ANDERLIK; & ASSOCIATES; INC.        !
*****************************************************************
```

#11507 CHASKA WEST CREEK – SUPERCRITICAL FLOW CHANNEL
2/18/84

MEMBER #: 1 SECTION : 12 x 16 LENGTH : 10.00

	End 1	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 2
Fu	Max	0	Min	0		Min	0	Max	0
Mu-	41214	28567	17909	10373	5321	2257	683	103	0
Mu+	0	0	0	0	0	0	0	0	0
Vu	10304	9932	7122	4936	3147	1756	762	166	0

MEMBER #: 2 SECTION : 12 x 24 LENGTH :%1310.00

	End 4	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 5
Fu	Max	0	Min	-2671		Min	-2671	Max	0
Mu-	0	0	0	0	0	0	0	0	0
Mu+	0	0	0	0	0	0	0	0	0
Vu	0	0	0	0	0	0	0	0	0

MEMBER #: 3 SECTION : 12 x 24 LENGTH :%1310.00

	End 6	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 7
Fu	Max	0	Min	-1715		Min	-1715	Max	0
Mu-	0	0	0	0	0	0	0	0	0
Mu+	0	0	0	0	0	0	0	0	0
Vu	0	0	0	0	0	0	0	0	0

MEMBER #: 4 SECTION : 12 x 24 LENGTH :%1310.00

	End 8	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 9
Fu	Max	0	Min	-791		Min	-791	Max	0
Mu-	0	0	0	0	0	0	0	0	0
Mu+	0	0	0	0	0	0	0	0	0
Vu	0	0	0	0	0	0	0	0	0

MEMBER #: 5 SECTION : 12 x 24 LENGTH :%1310.00

	End 10	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 11
Fu	Max	270	Min	0		Min	0	Max	270
Mu-	0	0	0	0	0	0	0	0	0
Mu+	0	0	0	0	0	0	0	0	0
Vu	0	0	0	0	0	0	0	0	0

MEMBER #: 6 SECTION : 12 x 24 LENGTH :%1310.00

	End 12	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 13
Fu	Max	1509	Min	0		Min	0	Max	1509
Mu-	0	0	0	0	0	0	0	0	0
Mu+	0	0	0	0	0	0	0	0	0
Vu	0	0	0	0	0	0	0	0	0

****

! BONESTROO; ROSENE; ANDERLIK; & ASSOCIATES; INC. !

****

#11507 CHASKA WEST CREEK - SUPERCRITICAL FLOW CHANNEL
2/18/84

MEMBER #: 7 SECTION : 0 x 0 LENGTH :%1310.00

	End 14	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 15
Fu	Max	0	Min	0		Min	0	Max	0
Mu-	0	0	0	0	0	0	0	0	0
Mu+	0	0	0	0	0	0	0	0	0
Vu	0	0	0	0	0	0	0	0	0

MEMBER #: 8 SECTION : 0 x 0 LENGTH :%1310.00

	End 16	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 17
Fu	Max	0	Min	0		Min	0	Max	0
Mu-	0	0	0	0	0	0	0	0	0
Mu+	0	0	0	0	0	0	0	0	0
Vu	0	0	0	0	0	0	0	0	0

MEMBER #: 9 SECTION : 0 x 0 LENGTH :%1310.00

	End 18	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 19
Fu	Max	0	Min	0		Min	0	Max	0
Mu-	0	0	0	0	0	0	0	0	0
Mu+	0	0	0	0	0	0	0	0	0
Vu	0	0	0	0	0	0	0	0	0

MEMBER #: 10 SECTION : 0 x 0 LENGTH :%1310.00

	End 20	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 21
Fu	Max	0	Min	0		Min	0	Max	0
Mu-	0	0	0	0	0	0	0	0	0
Mu+	0	0	0	0	0	0	0	0	0
Vu	0	0	0	0	0	0	0	0	0

MEMBER #: 11 SECTION : 0 x 0 LENGTH :%1310.00

	End 22	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 23
Fu	Max	0	Min	0		Min	0	Max	0
Mu-	0	0	0	0	0	0	0	0	0
Mu+	0	0	0	0	0	0	0	0	0
Vu	0	0	0	0	0	0	0	0	0

MEMBER #: 12 SECTION : 0 x 0 LENGTH :%1310.00

	End 24	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 25
Fu	Max	0	Min	0		Min	0	Max	0
Mu-	0	0	0	0	0	0	0	0	0
Mu+	0	0	0	0	0	0	0	0	0
Vu	0	0	0	0	0	0	0	0	0

```
***************************************************************
!       BONESTROO; ROSENE; ANDERLIK; & ASSOCIATES; INC.       !
***************************************************************
```

#11507 CHASKA WEST CREEK – SUPERCRITICAL FLOW CHANNEL
2/18/84

MEMBER #: 13 SECTION : 0 x 0 LENGTH :%1310.00

	End 26	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 27
Fu	Max	0	Min	0		Min	0	Max	0
Mu-	0	0	0	0	0	0	0	0	0
Mu+	0	0	0	0	0	0	0	0	0
Vu	0	0	0	0	0	0	0	0	0

MEMBER #: 14 SECTION : 12 x 24 LENGTH : 1.00

	End 3	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 5
Fu	Max	0	Min	-6106		Min	-6106	Max	0
Mu-	4	19	67	148	261	407	585	797	1040
Mu+	0	0	0	0	0	0	0	0	0
Vu	8	253	514	775	1036	1297	1558	1820	2081

MEMBER #: 15 SECTION : 12 x 24 LENGTH : 2.00

	End 5	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 7
Fu	Max	0	Min	-6106		Min	-6106	Max	0
Mu-	1044	964	1014	1195	1506	1948	2521	3224	4057
Mu+	0	0	0	0	0	0	0	0	0
Vu	582	60	462	984	1507	2029	2551	3073	3595

MEMBER #: 16 SECTION : 12 x 24 LENGTH : 1.67

	End 7	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 1
Fu	Max	0	Min	-6106		Min	-6106	Max	0
Mu-	4057	4495	5024	5644	6360	7155	7972	8772	9556
Mu+	0	0	0	0	0	0	0	0	0
Vu	1880	2317	2753	3189	3667	3953	3873	3793	3714

MEMBER #: 17 SECTION : 12 x 24 LENGTH : 0.33

	End 1	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 9
Fu	Max	0	Min	-16409		Min	-16409	Max	0
Mu-	0	0	0	0	0	0	0	0	0
Mu+	31657	31393	31130	30867	30605	30344	30083	29823	29564
Vu	6406	6391	6375	6359	6343	6328	6312	6296	6280

MEMBER #: 18 SECTION : 12 x 24 LENGTH : 2.00

	End 9	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 11
Fu	Max	0	Min	-16409		Min	-16409	Max	0
Mu-	0	0	0	0	0	0	0	0	0
Mu+	29564	28202	26864	25550	24260	22993	21750	20532	19337
Vu	5495	5400	5304	5209	5114	5018	4923	4828	4732

```
*****************************************************************
!       BONESTROO; ROSENE; ANDERLIK; & ASSOCIATES; INC.         !
*****************************************************************
```

#11507 CHASKA WEST CREEK - SUPERCRITICAL FLOW CHANNEL
2/18/84

MEMBER #: 19 SECTION : 12 x 24 LENGTH : 2.00

	End 11	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 13
Fu	Max	0	Min	-16409		Min	-16409	Max	0
Mu-	0	0	0	0	0	0	0	0	0
Mu+	19338	18099	16884	15692	14525	13382	12262	11166	10094
Vu	5003	4908	4813	4717	4622	4527	4431	4336	4241

MEMBER #: 20 SECTION : 12 x 24 LENGTH : 2.00

	End 13	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 15
Fu	Max	0	Min	-16409		Min	-16409	Max	0
Mu-	0	0	0	0	0	0	0	0	640
Mu+	10094	8669	7268	5890	4536	3206	1900	618	0
Vu	5749	5653	5558	5463	5367	5272	5177	5081	4986

MEMBER #: 21 SECTION : 12 x 24 LENGTH : 2.00

	End 15	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 17
Fu	Max	0	Min	-16409		Min	-16409	Max	0
Mu-	639	1874	3085	4272	5435	6574	7690	8781	9849
Mu+	0	0	0	0	0	0	0	0	0
Vu	4986	4891	4796	4700	4605	4510	4414	4319	4224

MEMBER #: 22 SECTION : 12 x 24 LENGTH : 2.00

	End 17	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 19
Fu	Max	0	Min	-16409		Min	-16409	Max	0
Mu-	9849	10893	11913	12910	13882	14831	15756	16657	17535
Mu+	0	0	0	0	0	0	0	0	0
Vu	4224	4129	4034	3938	3843	3748	3652	3557	3462

MEMBER #: 23 SECTION : 12 x 24 LENGTH : 2.00

	End 19	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 21
Fu	Max	0	Min	-16409		Min	-16409	Max	0
Mu-	17542	18393	19221	20024	20804	21560	22292	23000	23684
Mu+	0	0	0	0	0	0	0	0	0
Vu	3452	3357	3262	3166	3071	2976	2880	2785	2690

MEMBER #: 24 SECTION : 12 x 24 LENGTH : 2.00

	End 21	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 23
Fu	Max	0	Min	-16409		Min	-16409	Max	0
Mu-	23691	24354	24994	25610	26202	26770	27314	27835	28331
Mu+	0	0	0	0	0	0	0	0	0
Vu	2702	2606	2511	2416	2320	2225	2130	2034	1939

```
************************************************************
!       BONESTROO; ROSENE; ANDERLIK; & ASSOCIATES; INC.      !
************************************************************
```

#11507 CHASKA WEST CREEK - SUPERCRITICAL FLOW CHANNEL
2/18/84

MEMBER #: 25   SECTION : 12 x 24   LENGTH : 2.00

	End 23	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 25
Fu	Max	0	Min	-16409		Min	-16409	Max	0
Mu-	28330	28801	29249	29673	30074	30450	30803	31132	31437
Mu+	0	0	0	0	0	0	0	0	0
Vu	1935	1839	1744	1649	1553	1458	1363	1268	1172

MEMBER #: 26   SECTION : 12 x 24   LENGTH : 2.00

	End 25	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 27
Fu	Max	0	Min	-16409		Min	-16409	Max	0
Mu-	31439	31720	31978	32211	32421	32608	32770	32908	33023
Mu+	0	0	0	0	0	0	0	0	0
Vu	1174	1078	983	888	792	697	602	506	411

MEMBER #: 27   SECTION : 12 x 24   LENGTH : 1.08

	End 27	Sec.1	Sec.2	Sec.3	Sec.4	Sec.5	Sec.6	Sec.7	End 28
Fu	Max	0	Min	-16409		Min	-16409	Max	0
Mu-	33004	33061	33110	33153	33189	33218	33239	33254	33262
Mu+	0	0	0	0	0	0	0	0	0
Vu	445	393	342	290	239	187	136	85	33

APPENDIX D

DETAILED COST ESTIMATE

APPENDIX D

DETAILED ESTIMATE OF FIRST COST

(October 1984 Price Levels)

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
FEDERAL FIRST COST				
Relocations				
Railroads				
Construct bridge	Job	Sum	* * *	205,000.00
Remove abandoned bridge	Job	Sum	* * *	12,240.00
Relocate railroad	Job	Sum	* * *	125,000.00
Subtotal				342,240.00
Contingencies				34,224.00
TOTAL RAILROAD				376,000.00
TOTAL RELOCATION				376,000.00
Channels				
Chaska Creek Diversion				
Excavation	C.Y.	134,400	2.00	268,800.00
Random backfill	C.Y.	69,500	1.50	104,250.00
Free draining granular material	C.Y.	31,000	12.00	372,000.00
Riprap (24" and less)	C.Y.	1,600	20.00	32,000.00
Riprap (48")	C.Y.	4,010	24.00	96,240.00
Riprap bedding	C.Y.	3,590	14.00	50,260.00
35' wide concrete channel	L.F.	1,973	774.00	1,527,102.00
37.5' wide concrete channel	L.F.	1,890	807.00	1,525,230.00
Subcritical channel	L.F.	100	820.00	82,000.00
Sand bedding	C.Y.	2,100	6.00	12,600.00
Levee fill	C.Y.	300	4.00	1,200.00
Filter fabric	S.Y.	44,400	3.50	155,400.00
Insulation	S.F.	293,500	0.70	205,450.00
Sheet pile shoring	S.F.	19,500	8.00	156,000.00
Timber shoring	S.F.	19,000	5.00	95,000.00
Fence	L.F.	7,470	9.00	67,230.00
Sheet pile cutoff walls	S.F.	6,280	15.00	94,200.00
Weep holes w/flap gates	Ea.	252	200.00	50,400.00
4" PVC drain	L.F.	1,000	2.65	2,650.00
Seeding	acre	10.2	1,000.00	10,200.00
Inlet structure	Job	L.S.	* * *	119,000.00
Stilling basin	Job	L.S.	* * *	159,000.00
Ogee spillway	Job	L.S.	* * *	56,000.00
Trash guard	Job	L.S.	* * *	22,000.00
Subtotal				5,264,212.00
Contingencies				526,421.00
TOTAL CHASKA CREEK DIVERSION				5,791,000.00

APPENDIX D

DETAILED ESTIMATE OF FIRST COST

(October 1984 Price Levels)

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
HICKORY STREET DIVERSION				
Excavation	C.Y.	6,700	2.00	13,400.00
Random backfill	C.Y.	2,600	1.50	3,900.00
Free draining granular material	C.Y.	1,200	8.00	9,600.00
Filter fabric	S.Y.	2,600	3.50	9,100.00
Insulation	S.F.	12,900	0.70	9,030.00
Sheet pile cutoff wall	S.F.	220	15.00	3,300.00
Security fence	L.F.	830	9.00	7,470.00
Seeding & mulching	Acre	0.4	1,000.00	400.00
Side inlet	Job	L.S.	* * *	165,000.00
Box culvert	L.F.	255	700.00	178,500.00
Transition	Job	L.S.	* * *	28,000.00
Drop structure	Job	L.S.	* * *	88,000.00
Sand bedding	C.Y.	80	6.00	480.00
Weephole & flap gates	Ea.	18	200.00	3,600.00
4" ϕ PVC Drain pipe	L.F.	70	2.65	186.00
Subtotal				524,766.00
Contingencies				52,477.00
TOTAL HICKORY ST. DIVERSION				577,000.00
TOTAL CHANNELS				6,368,000.00
LEVEES				
Excavation	C.Y.	2,800	2.00	5,600.00
Impervious backfill	C.Y.	37,800	1.50	56,700.00
Stripping	C.Y.	3,300	1.50	4,950.00
Inspection trench	L.F.	2,165	10.00	21,650.00
Seeding	Acre	9.0	1,000.00	9,000.00
Landscaping	Job	L.S.	* * *	22,000.00
Sandbag closure	Job	L.S.	4,080.00	4,080.00
Gatewell (S.G.)	Job	L.S.	* * *	16,000.00
Gatewell (F.G.)	Job	L.S.	* * *	12,000.00
60" RCP end section w/grate	Job	L.S.	* * *	3,000.00
Sluice gate, 60"x60"	Job	L.S.	* * *	20,000.00
Flap gate, 60"	Job	L.S.	* * *	8,000.00
Manholes, 60"	Ea.	2	2,000.00	4,000.00
Outlet (A)	Job	L.S.	* * *	5,000.00
24"ϕ CMP	L.F.	820	18.00	14,760.00
60" RCP, CL II	L.F.	600	150.00	90,000.00
60" RCP, CL III	L.F.	264	175.00	46,200.00
24" RCP inlets	Ea.	2	1,000.00	2,000.00
Subtotal				344,940.00
Contingencies				34,494.00
TOTAL LEVEES				379,000.00

APPENDIX D

DETAILED ESTIMATE OF FIRST COST

(October 1984 Price Levels)

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
TOTAL CONSTRUCTION COST				7,123,000.00
TOTAL ENGINEERING AND DESIGN				855,000.00
TOTAL SUPERVISION AND ADMINISTRATION				499,000.00
TOTAL FEDERAL FIRST COST				8,477,000.00
NON-FEDERAL FIRST COSTS				
Relocations				
Bridge removal				
Hwy. 10 road raise				
Guardrail	L.F	540	15.00	8,100.00
Remove road	S.Y.	560	2.00	1,120.00
Subbase	C.Y.	520	4.00	2,080.00
Base course	C.Y.	130	16.00	2,080.00
Surface course	S.Y.	560	12.00	6,720.00
Remove Hillside Bridge	Job	L.S.	* * *	15,300.00
Remove 1st St. Bridge	Job	L.S.	* * *	15,300.00
Subtotal				50,700.00
Contingencies				5,070.00
TOTAL BRIDGE REMOVAL				56,000.00
Bridge Modifications				
Hillside Drive Bridge	Job	L.S.	* * *	100,000.00
Hickory St. Bridge	Job	L.S.	* * *	90,000.00
First St. Bridge	Job	L.S.	* * *	95,000.00
Subtotal				285,000.00
Contingencies				28,500.00
TOTAL BRIDGE MODIFICATIONS				314,000.00
Utilities				
West Creek				
Sanitary siphon	Job	L.S.	* * *	16,320.00
6" watermain crossing	L.F.	100	81.60	8,160.00
Relocate utility poles	Job	L.S.	* * *	30,600.00

APPENDIX D

DETAILED ESTIMATE OF FIRST COST

(October 1984 Price Levels)

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
8" VCP sewer	L.F.	2,200	13.25	29,150.00
Manholes	Ea.	5	3,060.00	15,300.00
8" C.I.P. main	L.F.	1,400	25.50	35,700.00
8" gate valve	Ea.	1	836.00	836.00
1 1/2" waterline	L.F.	50	5.50	275.00
Relocate hydrant	Ea.	1	2,040.00	2,040.00
Relocate utility lines	Job	Sum	* * *	20,400.00
Subtotal				158,781.00
Contingencies				15,878.00
TOTAL UTILITIES				175,000.00
TOTAL RELOCATION				545,000.00
<u>Lands and Damages</u>				
Rights of Way	Job	Sum	* * *	550,000.00
TOTAL LANDS AND DAMAGES				$550,000.00
TOTAL NON-FEDERAL FIRST COSTS				1,095,000.00
<u>TOTAL FIRST COSTS</u>				9,572,000.00

APPENDIX E

NON-FEDERAL COST-SHARING CORRESPONDENCE

APPENDIX E

TABLE OF CONTENTS

Engineering
Project Management

Honorable Tracy Swanson
Mayor of Chaska
205 East Fourth Street
Chaska, Minnesota 55318

Dear Mayor Swanson:

The Chaska, Minnesota, project is one of a number that the Corps of Engineers has under consideration as a potential new construction start in Fiscal Year 1986. However, as you probably are aware, efforts to control the budget deficits have limited the amount of Federal funds made available for such programs as development of water resources. It is inevitable that a higher degree of non-Federal cost-sharing and financing of water projects is both desirable and necessary if the water program is to be put on a sound basis.

To stretch the funds that may be made available for new construction starts, the Corps is seeking to work with those sponsors who, voluntarily, are willing to increase their share of both the construction and financing costs and jointly move ahead in implementing their project. This approach has been used before and the intent to enter into such voluntary agreements has been expressed by the sponsors of 14 projects. We would like to discuss with you the possibility of proceeding with the Chaska project under similar financial arrangements. To that end, I would like to arrange a meeting with you to discuss our program and what would be involved in funding the construction of your project.

Any project that we may include in the Fiscal Year 1986 budget is subject to review and approval by both the OMB and the Congress. However, I might point out that both houses of Congress have under consideration bills which also will increase the non-Federal share of project funding. Any contractual agreement based on our proposals would allow modification of the agreement to reflect the provisions of any legislation subsequently enacted into law. Of course, we fully understand that you will want to weigh the advantages and disadvantages in your own situation, as well as all the options open to you. Whether or not you wish to proceed with us is entirely your option.

In any case, I want to offer what I believe is a realistic program for moving ahead with good water projects in Fiscal Year 1986. I hope you are interested and that I will hear from you by August 31, 1984. Time is important if your project is to be a candidate for inclusion on the Fiscal Year 1986 construction program now being developed.

Sincerely,

Edward G. Rapp
Colonel Corps of Engineers
District Engineer

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
1135 U S POST OFFICE & CUSTOM HOUSE
ST PAUL MINNESOTA 55101

REPLY TO
ATTENTION OF:

NCSED-M

31 AUG 1984

SUBJECT: Initial Contact Report, FY 1986 New Construction Start, Minnesota River at Chaska, Minnesota

Commander, North Central Division

1. On 28 August 1984, I met with officials of the city of Chaska, Minnesota, the local sponsor for the subject project, to discuss the potentials of a FY 1986 new construction start for their project. I discussed the following items with them at the meeting:

   a. FY 1986 budget cost-sharing policies for new construction starts.

   b. ASA(CW) requirements.

   c. Letter of agreement.

   d. City of Chaska's ability to pay.

2. The city of Chaska is interested in the new construction start, but appeared apprehensive about their capability to fund their portion of the project. They are currently evaluating sources of revenue available for the project. I assured them that my staff would work closely with them in the next few weeks to develop a funding plan which would be consistent with their capability.

3. I have not been contacted by any congressional interests concerning this meeting or this budget exercise for the Chaska project.

4. The city of Chaska is seriously analyzing their support of the FY 1986 new start program and the financial impact it will have upon their community. They intend to present their findings in a public hearing to arrive at a decision.

EDWARD G. RAPP
Colonel, Corps of Engineers
Commanding

Chaska

October 16, 1984

Colonel Edward G. Rapp
District Engineer
U.S. Army Corps of Engineers
1135 U.S.P.O.
St. Paul, Minnesota 55101-1479

Dear Colonel Rapp:

Reference is made to your letter of August 17, 1984, and to our discussions regarding construction of the Chaska, Minnesota flood control project. This letter constitutes an expression of intent by the City of Chaska to cooperate with the Federal Government in initiating construction of the Chaska project in Government Fiscal Year 1986.

To facilitate construction of the Chaska project the City of Chaska will provide the following items of local cooperation required by Section 1 of the 1974 Water Resources Development Act and other applicable laws:

a. Provide without cost to the United States all lands, easements, and rights-of-way, including borrow areas and disposal areas for excavated material determined suitable by the Chief of Engineers and necessary for construction of the project;

b. Hold and save the United States free from damages that may result from construction of the project, not including damages due to the fault or negligence of the United States or its contractors;

c. Maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of the Army (this is based on subsequent statute);

d. Accomplish without cost to the United States all relocations and alterations of buildings, transportation facilities, storm and sanitary sewer systems, public and private utilities, local betterments, drainage facilities, and other structures and improvements made necessary by construction of the recommended plan, excluding railroad bridges and approaches and facilities necessary for the normal interception and disposal of local interior drainage at the line of protection;

e. Prescribe and enforce regulations to prevent obstruction or encroachment on channels and temporary storage areas which would reduce their flood-carrying or storage capacity or hinder maintenance and operation; if ponding areas are impared, provide promptly and without cost to the United States substitute storage areas or equivalent pumping capacity;

f. Provide a cash contribution for recreation equal to 50 percent of the final separable cost allocated to this function, as outlined in the recreation cost-sharing contract.

g. Publicize floodplain information in the areas concerned and provide this information to zoning and other regulatory agencies for their guidance and leadership in preventing unwise future development in the floodplain. Provide guidance and leadership in adopting such regulations as may be necessary to ensure compatibility between future development and protection levels provided by the project; and

h. Inform affected interests at least annually of the limitations of the protection afforded by the project.

i. Comply with Section 601 of the Title IV of the Civil Rights Act of 1964 (Public Law 88-352) and the Department of Defense Directive 5500.11 pursuant thereto and published in Part 300 of Title 32, Code of Federal Regulations, in connection with the maintenance and operation of the project.

j. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, approved 2 January 1971, in acquiring lands, easements and rights-of-way, for construction and subsequent maintenance of the project and inform affected persons of pertinent benefits, policies, and procedures in connection with said Act.

As you are aware at the present time no agreement has been reached between the three branches of the Federal government regarding the required local share of the project costs. In 1976, at the time Chaska Flood Control Project was authorized for construction, the local community was financially responsible for providing all land, easements and right-of-ways.

Based on the present cost estimate, these local requirements would amount to $4.7 million. The House of Representatives during 1984 passed legislation increasing the local share to 25% of the total project costs. It is our understanding that the administration and the Corps of Engineers are proposing a local share of 35% for projects such as that proposed for Chaska. During the 1984 session the Senate was unable to agree on any specific local cost share.

If the final local share is 35% Chaska's contribution would be $9,659,000. Based upon our preliminary financing plan the 35% local share would necessitate a 9.15 annual mill rate increase over a 20 year period. The effect of such an increase would be to increase the City's tax levy by 56%.

Assuming the ultimate local share requirement is 25% Chaska's dollar contribution to the project would be $6,925,000 resulting in an estimated mill rate increase per year of 2.5 mills or 15%.

The City strongly supports limiting the increase in the local cost share to a maximum of 25% of the project and, consequently supports the House bill (House File 3678) which was passed during the 1984 legislative session. Changing from the traditional cost sharing approach to the proposed 25% local share would have the effect of increasing Chaska's contribution from $4.7 million to $6.9 million.

The City of Chaska will provide such funds as are necessary to meet the non Federal requirements for construction during the term of construction. The City would support whatever local share option ultimately is adopted by Congress and approved by the President.

It is understood that the local cooperation provisions of the 1976 Water Resources Development Act as specified previously are a non-Federal responsibility and that the City of Chaska will bear the full costs thereof, regardless of any cost sharing percentages established by Congress. It is also understood that the City of Chaska will bear the costs of operating and maintaining the project upon completion of construction in accordance with regulations prescribed by the Secretary of the Army.

The project to be constructed is that generally described in General Design Memorandum, Minnesota River at Chaska, Minnesota, dated February 1984. Based on the total estimated project cost of $27,710,000, the City intends to make its required local share payment in four equal annual installments beginning in 1986. These payments are based on the assumption that construction is initiated in 1986. It is understood that estimates of costs are preliminary and that final costs will depend on the actual costs of construction.

The City of Chaska is the agency empowered by law to provide the non-Federal cooperation required for the Chaska flood control project and prior to construction will enter into a binding written agreement with appropriate representatives of the Corps of Engineers which addresses project construction and satisfies the requirements of Section 221 of Public Law 91-611. Finally, the Corp of Engineers should be aware that the City is concerned regarding the requirement that the 221 agreement would, under present regulations, require the City to commit to the project prior to determination of final costs. Given the financing mechanisms available to the City of Chaska, the uncertainty of City final costs could create difficulty.

In submitting the Letter of Intent the City does so with understanding the number of issues that are yet unresolved relating to actual design, local costs and financing alternatives available to the City. In particular the City is concerned regarding the final resolution of the credits allowed for existing facilities and the necessity for bridge relocation. The City does feel, though, that mutual resolution of these issues can be reached as the project approval proceeds.

It is further understood that if the City of Chaska cost sharing proposal is acceptable to the ASA(CW), he will recommend to the Office of Management and Budget that an appropriate request for funds to support Chaska, Minnesota construction be included in the President's budget for Fiscal Year 1986. As previously recognized, if legislation is enacted which changes cost sharing for Chaska, Minnesota, such cost sharing provisions will supercede this financial agreement.

Sincerely,

Tracy D. Swanson

Tracy D. Swanson
Mayor, City of Chaska

TDS:jai

Chaska

October 30, 1984

Colonel Edward G. Rapp
District Engineer
U.S. Army Corps of Engineers
1135 U.S.P.O.C.H.
St. Paul, MN 55101-1479

Dear Colonel Rapp:

This is to clarify our letter of October 16, 1984 regarding the Chaska, Minnesota Flood Control Project.

It is our intention to provide, during the construction period 35% of the cost allocated to flood control, toward which the cost of land and relocations will be credited. It is understood that if legislation is enacted which changes cost sharing for the project, such cost sharing provisions will supersede this agreement.

Sincerely,

Tracy D. Swanson

Tracy D. Swanson
Mayor, City of Chaska

TDS:jai

City of Chaska Minnesota 205 East Fourth Street 55318-2094 Phone 612 448-2851